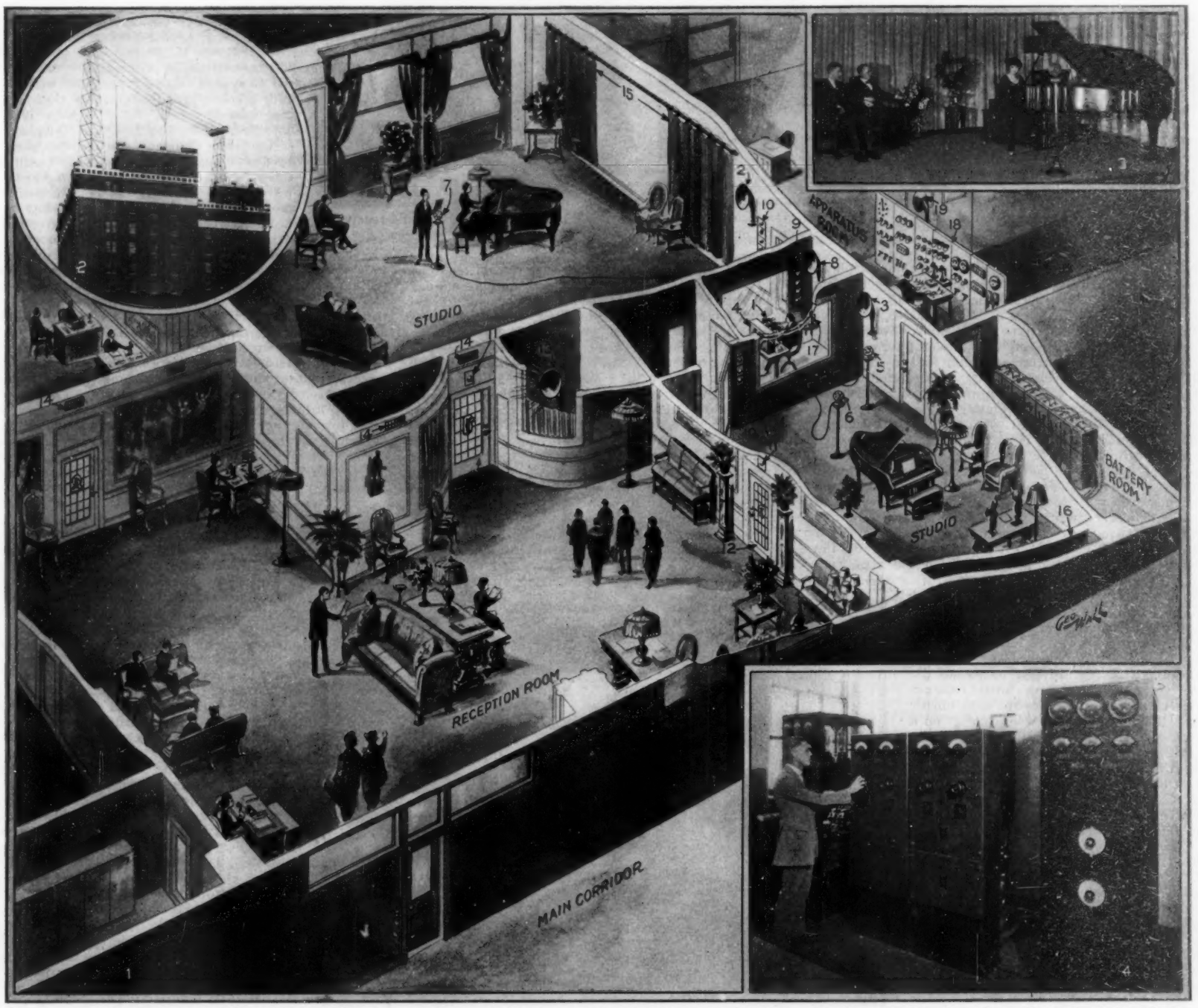
EIGHTIETH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, MAY, 1924



THE announcer's microphone (1) is located in a sound-proof announcing booth having double plate glass windows and giving clear vision to both studios. Special walls render the booth practically impervious to sounds from the studios. The loud speakers (2 and 3) in the studios repeat the announcer's introduction of artists and also enable him to give directions regarding placement of instruments and singers while the studio is idle. Switches on the announcer's control panel (4) enable him to switch in his own announcing microphone or those in large and small studio (5, 6 and 7). There are two microphones in each studio, one regular and one emergency. The announcer's loud speaker (8) enables him to hear the performance as heard by the radio audience so that his directions are given from the audience's point of view. The signal lights (9 and 10) indicate by colored lights whether or not the studio is on the air, the carrier wave is being sent out, the microphones are switched in or studio director or announcer is wanted on the telephone. Each door to the studios has a red signal light (11) which indicates that the studio is on the air. If any one disregards this signal and opens the door when transmission is taking place, the loud speakers are automatically disconnected. As a further precaution the doors (12) are equipped with special knobs which can be opened only by some one familiar with them. A loud speaker (13) concealed in a horn closet, reproduces the broadcast entertainment for the reception room. A ventilation system through ducts (14) keeps the studios and reception room cool and comfortable under all conditions even though all windows are closed. Adjustable deadening curtains (15) are readily adapted to suit the music being transmitted. A double wall with dead air space (16) prevents radiation of hall and elevator noises from the main corridor to the studio. The announcer, who is the key to the whole situation, is in direct communication with the engineers through desk telephone (17). The equipment panels (18) are mounted with all the necessary apparatus for controlling the microphone amplifiers and input currents to the special cables connecting the studio with the broadcasting station as well as controlling and adjusting remote control telephone lines which operate the station from outside points. Special equipment for equalizing lines to correct attenuation, as well as instruments for measuring the gain of any amplifier and group of amplifiers, is provided. Behind the panels is a large loud speaker (19) which provides the monitoring engineers with either the studio output or with the output of a loop radio receiver. The individual views show (1) the studio, (2) aerial, (3) broadcasting, (4) control board.

THE RADIO BROADCASTING STUDIO OF 1924: A VISIT TO STATION WEAF IN NEW YORK CITY

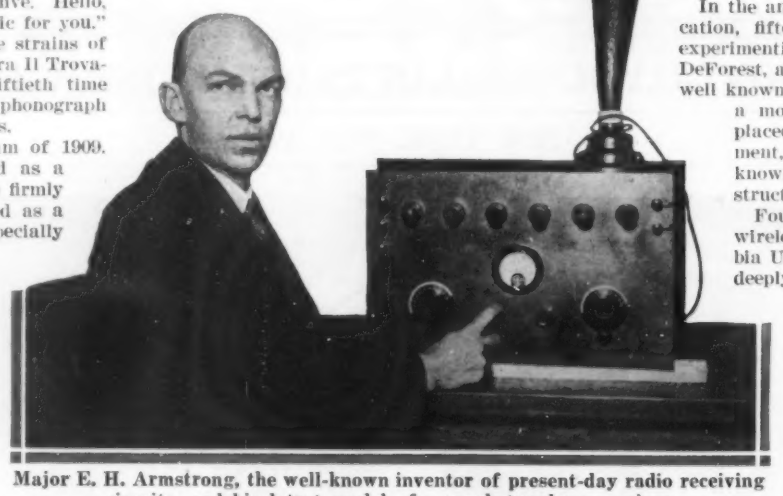
"This Is Station ——"

Putting Radio Programs On the Air and Taking Them Out of the Air

By Austin C. Lescarboura, Mem. A.I.E.E.
Author of "Radio for Everybody," "Wireless Course," etc.

ONE, two, three, four, five. Hello, Fort Wood. One, two, three, four, five. Hello, Fort Wood. Here's some music for you." And a moment later came the strains of the Anvil Chorus from the opera Il Trovatore, played for about the fiftieth time that day by the hardworking cylinder-type phonograph of rather questionable musical attainments.

That was the radio broadcasting program of 1909. As a matter of fact it was not intended as a broadcast feature. Back in those days we firmly believed that radio telephony might be used as a rapid means of wireless communication, especially for military operations. Of course we appreciated the fact that the radio telephone conversation could be intercepted by anyone, but it never occurred to us that this means of communication might be employed for nation-wide entertainment. Little did we dream that the very weakness of radio telephony—its total lack of secrecy—would some day become its greatest asset.



Major E. H. Armstrong, the well-known inventor of present-day radio receiving circuits, and his latest model of super-heterodyne receiver

With Sputtering Arc and Baked Microphone

No beautiful broadcasting studio was available in those pioneer days for our radio telephone efforts. Instead, we were working in the icy-cold room of the wireless station located behind the big disappearing guns of Fort Hancock, amid the barren wastes of that stick of land known as Sandy Hook. No neat and almost invisible microphone was presented for our vocal talent; instead, we were shouting into a long fiber horn, as we stood before a large table fitted with a tall back covered with delicate electrical meters and fuses and switches. Immediately before us were ten tall copper cylinders, filled with water, and resembling nothing so much as the pipes of an organ. Below each copper cylinder was a large carbon button, all but pressing against the bottom of its respective cylinder. Between the cylinder and the carbon button played an unsteady electric arc, sputtering and flickering all the while. The ten arc units were arranged in two banks of five arcs each, each bank controlled by a large upright handle, so that all five arcs of the bank might be struck at once. Once the arcs were formed by touching and then separating the copper and carbon members, it was necessary to adjust the gap of the arc so as to get the utmost stability, making for uniform radio waves on which to impress the telephone message or music. And here was the annoying feature; for no sooner did we get one of the arcs fairly constant and turned our efforts to the next unruly arc, than the first arc would go off on a rampage, electrically speaking.

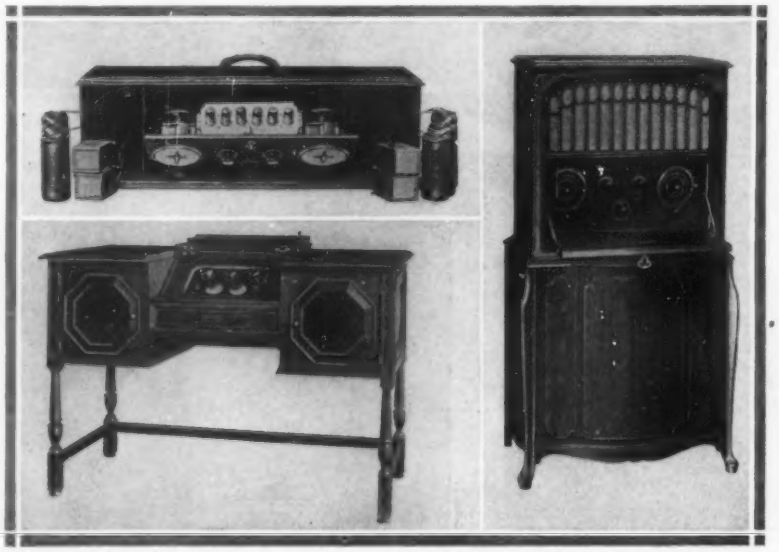
Given exceptional luck, it was possible at times to get all ten arcs on their best behavior. This happy state of affairs was confirmed by the passive state of one of the electrical instruments known as the oscillating circuit milli-ammeter.

The next step was to prepare to talk. The microphone, or device which translates sound waves into their electrical equivalents, was in this case a flat cartridge with two contact buttons. It was slipped into a holder over which was placed the long fiber horn. Then, if the arcs were still behaving themselves, we were ready to talk—or shout, to be more precise in our description.

All of which was for the purpose of convincing the United States Army Signal Corps that here was a wireless telephone that would work—on occasion. We were endeavoring to put some sounds into the air at Fort Hancock, and trying to get those same sounds out of the air again at Fort Wood, eighteen miles away as the crow flies. The Fort Wood receiving station was by no means of fortunate location, so far as radio is concerned, because it nestled right at the very feet of the bronze lady known as the Statue of Liberty. Despite the application of a five-kilowatt input at the transmitter—just ten times as much energy as the usual present-day broadcasting station—we could only hope to get through to our anxious listeners-in once in a great while.

The output from our arc transmitter was passed in large measure through the cartridge microphone, with the consequence that the loose carbon grains of the microphone were soon baked into a solid mass by the developed heat. All the while we were speaking or playing the phonograph, it was necessary to rap the microphone holder with a screw-driver so as to break up the baked carbon grains in order that the sound waves could be accurately translated into variations of the outgoing radio waves. At the end of several minutes of more or less uncertain transmission, the microphone would be baked solid and a new one would be necessary.

That, in brief, was the 1909 model of radio broadcasting station. The author, who participated in those early radio telephone attempts, had no illusions about the possibilities of radio telephony. To him, as well as to others engaged in that early experimental work, the technical obstacles were such as to seem insurmountable. As a laboratory experiment, the radio telephone was indeed interesting; but as an everyday convenience, it was doomed to failure.



Three 1924 models of radio receivers. Upper left: Standard super-heterodyne partly open to show the six tubes, tuning condensers and batteries. Lower left: Handsome period cabinet receiver. Right: Cabinet type regenoflex receiver, with self-contained loud-speaker

And Along Came the Vacuum Tube

In the annals of a young art like wireless communication, fifteen years is an age. Even as we were experimenting with our crude arc transmitter, Lee DeForest, a wireless experimenter and inventor already well known at that time, was at work on his audion—a modified form of electric bulb in which are placed two elements in addition to the usual filament, one of these a metallic plate or cylinder, known as the "plate," and the other a lattice-like structure known as the "grid."

Four years after our disheartening efforts at wireless telephoning, a young student at Columbia University, Edwin H. Armstrong, was delving deeply into the intricacies of the audion or vacuum tube, and evolving new and wonderfully efficient circuits for radio transmission and reception. That was in 1913. Two years later, the American Telephone & Telegraph Company startled the world by assembling a large battery of vacuum tubes for the purpose of generating radio waves with which the human voice was projected through space from Arlington to Paris. Then, as if the spanning of the Atlantic were not a sufficient accomplishment, the telephone engineers immediately followed up this feat by talking between Arlington and the far-away Pearl Harbor in Hawaii, a distance of 7500 miles. That was in 1915, the same year that the trans-continental telephone line was inaugurated—an astounding engineering achievement also due in large measure to the application of the vacuum tube, this time as a perfect "repeater" to build up attenuated voice currents at intervals on their long journey from coast to coast.

From 1915 the story of the radio telephone moves along through the trying days of the World War. With our entrance into the fight, we found it necessary to develop the radio telephone as a means of rapid communication between airplanes and the ground. It is safe to say that years of normal radio development were crowded into months in those days of great anxiety.

Then came 1921. The Westinghouse organization began a series of radio telephone experiments for the purpose of testing certain microphones and radio telephone transmitters. Soon the radio amateurs took keen interest in those experiments. After a while the Westinghouse organization found that its experiments were coming to be looked upon as a public institution. Aside from radio amateurs, who are primarily interested in communicating with one another by means of the dot-dash language of the telegraph code, numerous laymen were buying receiving apparatus so as to listen in on these experimental talks and phonographic concerts which could be taken out of the air.

So radio broadcasting came about, and the rest of the story is of too recent origin to require reiteration at this time. If anything, it is the present-day vacuum tube which has made radio broadcasting possible. The pioneer workers, making use of the troublesome and uncertain carbon arc for generating the radio waves, were hopelessly handicapped. Not only was the carbon arc most inefficient in the generation of radio energy, but such energy as it did produce had to be handled more or less directly with a microphone which could not stand up under such an electrical strain. Back in our 1909 experiments we had to change microphones about every five minutes—and each microphone cost us about $3.00!

Now the vacuum tube is the marvel of modern electricity. It can be used to convert direct current into alternating current of very high frequencies, suitable for radio transmission. Feed it alternating current of any frequency, and it will convert such current into direct current. It may be used to detect delicate radio waves; in fact, it is a super-sensitive detector in radio work. The vacuum

tube acts as a relay or repeating device, in that it will impress on a powerful current every characteristic of a weak current. It is this facility which permits of using the vacuum tube as an amplifier in radio receiving, or as a so-called modulator in radio transmission, when the delicate voice currents are impressed on the powerful transmitting waves, or as the repeater in the long-distance telephone line, when it becomes necessary to boost up the attenuated telephone currents at the end of every so many hundred miles of line.

The Gentle Art of Broadcasting

How quickly we have become accustomed to broadcasting! Only a few years back we were contented to spend our evenings reading the newspaper, a magazine, or a bulky book. If we desired a little entertainment, we went to the nearby motion picture house or to the theatre. Or we even called on our friends in order to pass the evening.

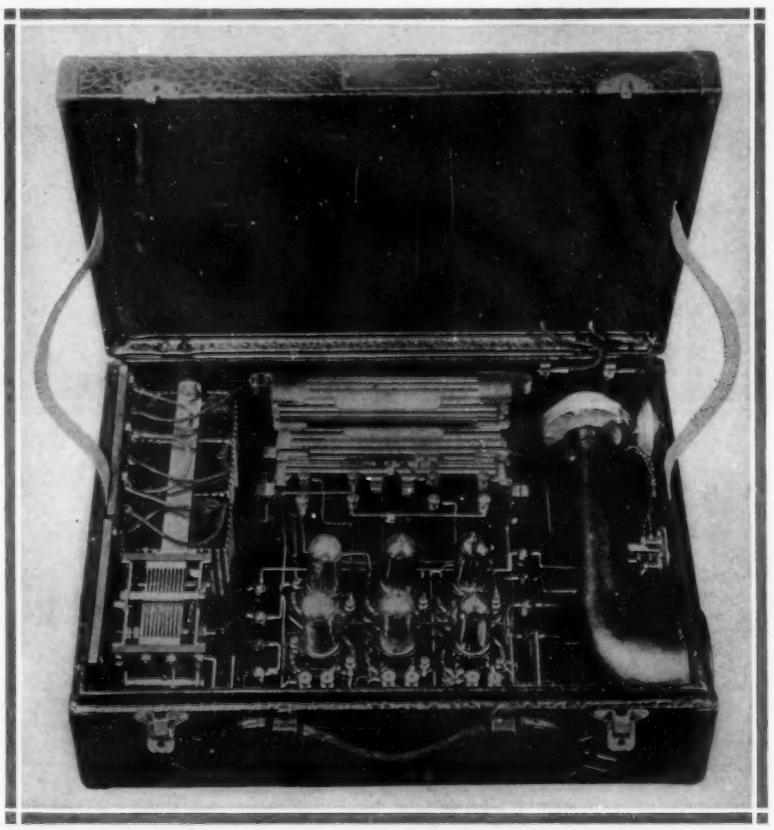
Today it is quite different. On our way home we look through our newspaper for the radio programs. We learn what is going to be put on the air tonight for our entertainment. Not only do the radio programs tell us the names of the artists and speakers as well as their offerings, but also the exact time at which we can look for those very features. Instead of having to go out for our entertainment, we have merely to turn the dials of our radio receiver to the proper settings, and the entertainment comes to us from out of the sky. It is now too commonplace to be fully appreciated, this wonderful thing called broadcasting.

There are two sides to radio broadcasting: first, the talk or the music must be put on the air by means of a radio telephone transmitter; secondly, the talk or the music must be taken out of the air by means of a receiving set. The radio waves which carry the talk or the music are strongest when nearest to their source, and gradually grow weaker as they spread out in ever widening circles to the vast radio audience. The object of the receiving set is to intercept a small portion of the desired radio wave in its immediate vicinity, by means of "tuning" or adjusting the frequency of the set to the desired wave, and then convert the energy of that radio wave into a replica of the original sounds. The nearer we are to the broadcasting station, the more powerful the waves and therefore the more radio energy can be intercepted. Furthermore, the more powerful the radio energy that is being handled by the receiving set, the simpler the apparatus required.

All of which may be quite elementary but is quite necessary in preparing us for an understanding of the present trend of broadcasting.

The latest statistics disclose that there are in the United States and Canada something like 600 radio broadcasting stations. Of this number, approximately 130 are using 500 watts or more. These stations are sufficiently scattered so as to blanket the entire country.

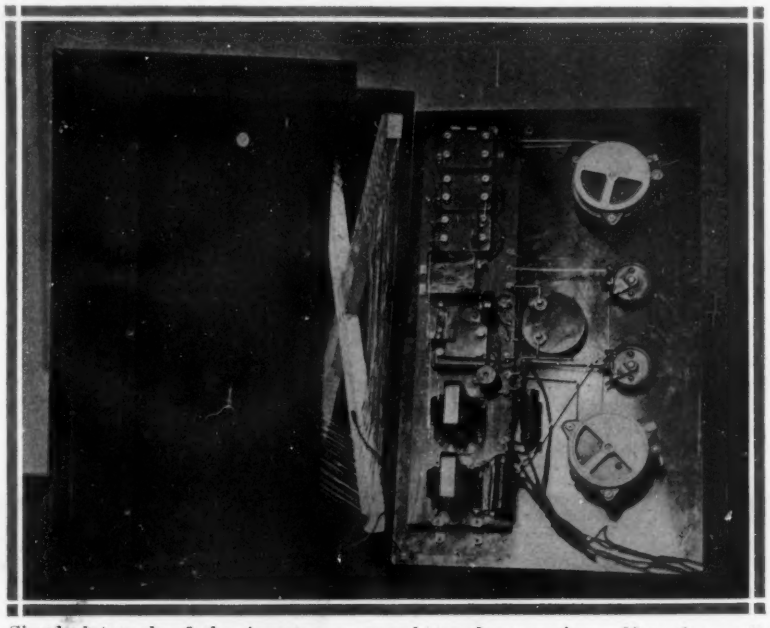
At first glance, this would appear to be a splendid thing—six hundred broadcasting stations putting as many programs on the air day after day. Surely, one need never worry about picking up an enjoyable program, in view of the variety offered by the combined efforts of the broadcasters. But unfortunately, this is one case where quantity is of secondary consideration if, in truth, it is not of the very first consideration. With so many high-power stations there is, if receiving conditions are good as in the cold, crisp winter evening, a considerable overlapping of wave lengths and, as a result, more or less interference. Hence the listener-in needs a high-grade set in order to pick out any particular station and bring it in so that the quality is good. This is especially true if he is located in the vicinity of one of the undesirable stations.



Typical multi-tube radio frequency portable set, with self-contained loud-speaker. The loop is in the lid of the case

Then, to make the situation worse, the public is bent upon long-distance reception. Why it is essential that we listen to the impossible program of the Podunk Fire Department's band playing from the Podunk station, when the nearby station is broadcasting Paul Whiteman's famous dance provocatives, would be a deep mystery except for the fact that Podunk is 2281 miles distant. Distance lends enchantment. And there you are.

In an effort to obtain distance, in too many cases the listener tries to "get" stations that are beyond the proper capacity of his receiving apparatus, which results in forced regeneration in what is known as the regenerative receiver. Forced regeneration causes the receiver to act as a miniature transmitter which emits a radio wave of about the same wave length as the station that is being listened to with more or less success. Meanwhile, other listeners-in within a quarter of a mile or more are picking up the emitted wave which now gives rise to a whistle in their head-phones or loud-speaker. This case, multiplied by dozens of others in the case of a small community, or by thousands in the case of a large city, results in a bedlam of whistles, groans, shrieks and whatnot which break up the radio programs for many of the radio audience. Unfortunately, for the past two years our short-sighted radio manufacturers have flooded the country with regenerative sets of the most offensive types.



Simple internals of the Armstrong super-heterodyne receiver. Note the small loop which intercepts the radio wave

In many localities the condition in this respect is deplorable. Broadcasters who take particular pride in their efforts are greatly discouraged over this situation. The worst offenders in the production of these radio "birdies" are the builders of crude home-made sets. Sad to relate, the regenerative receiver is the simplest, cheapest and most effective type of receiving apparatus for the efforts of the amateur builder. To make matters still worse, the irresponsible dealers in radio equipment are forever dressing up the old regenerative receiver in some slightly different style and selling the parts to the gullible public under a new and high-sounding label. Were the regenerative receivers to be placed only in the hands of skilled and conscientious radio amateurs, there would be little if any of the unbecoming noises now heard; for, truth to tell, the regenerative receiver when properly operated does not emit a disturbing wave. In Great Britain, where our trials and tribulations as pioneers in this radio broadcasting art have been carefully studied, a regenerative receiver of any kind is positively tabooed.

A Better Receiver or More Powerful Transmitter—Which?

What is the remedy for this condition? That is a question which broadcasters and the radio industry and listeners-in have been asking themselves. In truth, this is the gravest problem which confronts the broadcasters, apart from the economical side which is quite another story.

There seem to be two remedies available in solving the present state of the air: first, the use of receivers which will not and cannot emit a wave of any kind; secondly, to bring the transmitter nearer to the receiving set either by piling on more power in our present broadcasting stations, or by installing more broadcasting stations at various points nearer to the listeners-in, and operating these stations as "repeaters" of a single program sent out from some central or primary station.

Maintaining its pioneering spirit in the broadcasting field, the Westinghouse organization has taken the initial step toward solving the present situation through the transmitting end. Instead of placing the burden on the radio audience, this organization has been working out a means of bringing the programs nearer to the receiving sets.

Here is how the thing can be done: Suppose we have a studio in New York, broadcasting the finest type of programs. In order to bring those programs within reach of the listeners-in throughout the Middle West, let us say, we must operate a powerful station somewhere in the Middle West. The same programs are to be re-broadcasted from the Middle West station, which is therefore a repeater station. Two methods are available for performing this service, one by telephone wire transmission between the New York studio and the Middle West repeater transmitter, and the other by the special wireless transmission of the programs—quite distinct from the regular broadcasting wave—the special waves being intercepted at the repeater station by means of a suitable receiver, and then led to the transmitter for re-transmission.

Now imagine, if you will, a number of these repeater stations located throughout the United States. This arrangement would give the radio audiences in every part of the country the finest programs available, indirectly from the Gay White Way or from the Nation's Capitol, in ample volume so as to be intercepted with the simplest receiver. Obviously, the repeater station

(Continued on page 338)

Experimental Telepathy

Tests by Dr. Carl Bruck, M.D., Berlin, on the Transmission of Drawings

Adapted by Dr. Alfred Gradenwitz from the Investigator's Report

NUMEROUS investigators have been attracted by the possibility that there exists, apart from the normal channels of communication through the recognized senses, a means of contact between human minds, a means for the interchange of information and ideas, of such sort as to make appropriate the use of the word "telepathy" in characterization. Of those who have entered this belief, some, like Coover of Leland Stanford, have concluded that telepathy does not occur, the apparent instances to the contrary being due to coincidence on the one hand, or to the unrecognized (and sometimes hyperesthetic) operation of the ordinary senses on the other. Investigators of the British Society of Psychical Research, on the other, having taken due precautions against these factors, still obtained results that indicated the passing of information in some way, which they considered it permissible—or even perhaps necessary—to recognize as telepathic.

Admittedly the more startling instances of apparent telepathy are quite spontaneous, and save by the rarest good fortune inaccessible to the investigator. Admittedly the attempt to produce the phenomenon experimentally works under grave disadvantages, as compared with the spontaneous operation of the telepathic faculty. But if when we say "telepathy" we mean simply a clairvoyance in space or time, or both, operating in a fashion not defined, there seems excellent reason to believe that this may occur, both spontaneously and, less reliably, under experimental conditions.

Perhaps the most ordinary mechanism for experimental telepathy is that in which ideas are fixed by means of rough pictures drawn by one experimenter, which the other experimenter attempts to reproduce under conditions of isolation against all normal communication. The attempt to secure such isolation is not a simple one. The investigator assumes an exceptional degree of scientific and moral responsibility for such sources of error as, apart from conscious and unconscious fraud by the subject, may be due to illusion on the part of the investigator himself. In my own experiments, I have attempted to gain security, against this sort of thing by keeping the drawings in portfolios throughout the test, so that they should be visible to *nobody;* while in the cases where this was not done, every precaution was taken to insure that there should be no visibility of the drawings to the subject, either directly or through reflection. Former experimenters have dealt satisfactorily with such obvious things as mirrors, pictures and window glasses; but they seem often to have overlooked the much more universal reflection on the cornea of the investigator or, possibly, on his eye-glasses. When such reflections exist, it need not be asked whether their perception by the subject would be conscious or unconscious, whether it would be entirely normal or would involve a visual hyperesthesia.

Objections to the use of drawings prepared by myself and known to nobody else were frequently met by tests with pictures improvised on the moment by other persons present. Such factors as the help possibly derived from motive automatisms of experimenter or spectator (unconscious whispers, animating mimics, gestures, etc.) likewise had my attention; and I feel that I can guarantee that none of my results were due to "muscle reading." The sittings were under the control of members of the Berlin Medical Society for Psychic Research. No mystic ritual was observed—there was no expectation affecting the mind, but likewise no intimidation or aggressive skepticism, liable to hamper the subject's psyche. Fraudulent maneuvers were never observed; all objections and reservations were invariably recorded, even though their futility were immediately realized. Particularly was the choice of too commonplace motifs for the drawings avoided, as well as those which, like the distinction between "yes" and "no," involved too simple a choice. It would seem that in any experiment to which it is hoped to attach significance, the topic present in the mind or on the paper of the experimenter should be of such sort as to offer the subject, in general terms, a hundred or more alternatives. Any conspicuous success will then defy explanation on the ground of chance coincidence.

The four persons experimented on in the tests here reported showed intense scientific interest, without any improper secondary intentions. They were young men between 18 and 24 years, civil servants or employes. One never returned after his first (negative) test; a second died after two very fine positive trials. The third, Mr. Z., submitted to 19 tests; but the bulk of the work was done with Mr. R., an unsalaried clerk of 18 in an optical institute. The tests were mostly made under hypnosis; and all four subjects proved easy to hypnotize. Alternating tests with and without hypnosis were made; and very good results were obtained in simultaneous tests with R and Z, both having their attention centered on the same drawing.

The experimenter's role was limited to a brief indication that, on intense concentration upon the original, this would make its appearance in the subject's internal perceptive field in such manner as to be readily recognized and copied. The results were made known to the subject and to the others present only *in toto*, at the termination of the sitting; for an immediate announcement of failure is known to hamper the psychic mechanism of the following numbers on the program. Short intervals were allowed between each two individual tests; nevertheless, fatigue was marked toward the end of each sitting.

The summation shows that of 108 sittings, 20 gave positive results; 32 results of more or less partial satisfaction; and 56 were negative. Two cases of failure should be eliminated as due to voluntary or involuntary suggestion from me. Inasmuch as there is not space here available for complete display of all these tests, only the more remarkable cases will be discussed here. Readers who desire more complete information are referred to the more complete report which will appear in book form (Julius Puttmann, Stuttgart); an English edition of this volume is contemplated.

The very first tests, two in number, with Mr. I (the subject who died), were in the deepest somnambulistic hypnosis. These were "open" tests, and in addition to the ordinary precautions against "mirror telepathy" the subject was seated at right angles to the experimenter rather than opposite him. Referring to this test, Figs. 1, 1A show a surprisingly faithful copy of a house with gabled roof, door and two windows. No importance, of course, is to be attached to correct drawing, the main point being the inclusion of the whole, or of one or two dominant features. On dehypnotization the subject showed complete amnesia, not being able to identify the house which he had copied, even when confronted with the original.

The numbers penciled upon the corners of the originals identify these; plain numbers 1, 2, etc., are the drawings made by the experimenter, while numbers suffixed by *a*, *b*, are the reproductions made, through a process presumed to be telepathic, by the subject or subjects. For full description, see the text

Six of Dr. Bruck's most striking apparent successes in telepathic transmission

In the case (Figs. 2, 2A, 2B) where the original consisted of the character 6, the positive result of Fig. 2A is slightly disguised by a somnambulistic automatism following closely upon the initial success. After the six had been properly copied, an auto-suggestive impulse to further drawing ensued, probably analogous to automatic writing or automatic art. The somnambulistic automatic component is distinctly seen to follow after the telepathic one; and a similar sequence was eventually noted, repeatedly, in the case of Mr. R. especially.

Figs. 3, 3A, 3B and 4, 4A, 4B—ladder and cup—are portfolio tests with R and Z in simultaneous hypnosis. Mr. R., to whom the A-figures pertain, was the more gifted here, from the artist's view, and automatic additions are found in the pail and the spoon; whereas, Mr. Z renders only the elements of the original, omitting even the saucer in 4B.

Figs. 5, 5A, come from a portfolio test with Mr. R. on a drawing rapidly improvised by one of the spectators in an adjoining room. Besides a reproduction accurate to the very details of the liqueur glass, there is here an automatic addition, eventually identified as a record from the mind of a little boy belonging to Mr. R's circle of acquaintances.

All further figures are from tests with Mr. R. In 6, 6A, such details as the wart, the deep folds of the upper lip and the sectional view of the right eye, are particularly evidential. This, like 7, 7A, 7B, was a portfolio test, offering no opportunity whatever for conscious or subconscious fraud. In the case of Fig. 7, we have, respectively, the result from using the same original with successive tests in and out of hypnosis. The subjects could not know that the same original was used, even if we ignore the fact that he was in hypnosis the first time.

The rhomboids of Fig. 8 illustrate admirably the

reproduction of the characteristic outline of the original. That this does not always occur, however, but that the subject's work may be limited to some significant individual element, appears in Fig. 9, serpent. Let the reader examine the thick head and the tapering half of the tail; the checkered central piece was missing and has been filled in by me. One can easily get here the impression of a defect in the field of metapsychic vision. Being a portfolio test behind the subject's back, this is of particular interest; the more so since the same original was repeated, three times, with the same curious result—the subdivision and gap in the telepathic drawing persisted.

Fig. 10 (scissors) shows a methodically continued series of tests from the same original. The component elements, the scissors-handle, were reproduced first as dumbbells and then as pincenez; and in the final test, made on Mr. R's express desire because of his only now having the feeling that he was sure of himself, the original appears in its totality, with much wealth of detail.

Numerous experimenters have reported a sort of telepathic lag, in which the drawing upon which a failure had but just been scored, would be successfully reproduced in connection with the next item, taking the place of the true original provided for this; and occasionally this lag extends over an even greater interval than consecutive tests. I have had five instances of this; but in Fig. 11 I illustrate the direct reverse phenomenon. In this case the original was a bottle; and the subject drew something like a hat. But I was struck with the likeness between the top portion of the original, the stopper with the bottle-neck, and the hat as drawn; so I requested Mr. R to go on drawing. He then left the hat *in statu quo*, and proceeded to make a new drawing below it, of the top of a street lantern; and this corresponded in every detail to the original, waiting in the portfolio, for the next test. If the displacement in time is to be regarded as a telepathic phenomenon, the anticipation and the lag must be dealt with and accounted for together.

A metapsychic explanation of anticipation and deferment has been attempted on the hypothesis that during the sitting the subject has telepathic access to the whole experimental complex prepared by the investigator. This, of course, is no explanation, but merely an alternative description of the phenomenon; withal it seems a very reasonable description.

In Fig. 12, a candlestick with candle was first rendered as a letter balance; it might be disputed whether this was a complete or only a partial failure. But an hour later, when the failure had been made known, Mr. R insisted upon a repetition, and faithfully reproduced the original. Whether this is a case of deferment or of gradual solution of the task, across an approximating intermediate result, is left to further interpretation of the case. (We assume that Dr. Bruck may be trusted to have made sure that it was not due to the subject's having in the meantime seen the original.—Editor.)

Further illustrations are crowded out, but the results of several interesting tests may be described without pictorial representation. A similar case to that of Fig. 12 involved a soup ladle, which was first rendered as a key (the dissimilarity of outline is not so pronounced as this statement might imply—Editor); later, in a repetition at Mr. R's insistence, the original was reproduced with great accuracy.

In some instances, a rather complicated picture was used, and a description in words asked for rather than a drawing. Thus, two fighting cocks facing one another, one being grayish black and the other brownish yellow, brought out a reference to a "black fowl." Told that the success was but partial, Mr. R asked to make the test in drawing, and produced two conventionalized curved figures in outline which could be reconciled with the cocks if one were determined to do so, but of which a more accurate estimate would be that their symbolism could not be identified. Over these he ultimately wrote the words "gray" and "yellow," in the correct order. The existence of two separate figures of unusual outline had been apprehended, with their color; the exact rendering of their shape had been, quite properly, subordinated. In connection with another descriptive test, employing a black-and-white drawing of spring scenery with shepherd and shepherdess, Mr. R saw a colored scene of autumnal character, with a farm. Moderately satisfactory as showing comprehension of the general effect, this is again inadequate in detail; the test ought, perhaps, have been continued.

As long as we can do nothing better than hazard vague guesses as to the psychic process involved in performances of this character, any such interesting details of the phenomena must be carefully kept on record. But so far from suggesting any new hypothesis of telepathy, experimenters, as a rule, should be content with simple queries. Thus following Prof. Oesterreich, we may ask:

"Is it a case of direct television or clairvoyance by the subject with regard to the object (the drawing, for example), without any active cooperation by the experimenter or any other agent?

"Or is it possibly some sort of physical transmission of the physiological process of vision or perception from the experimenter to the subject?

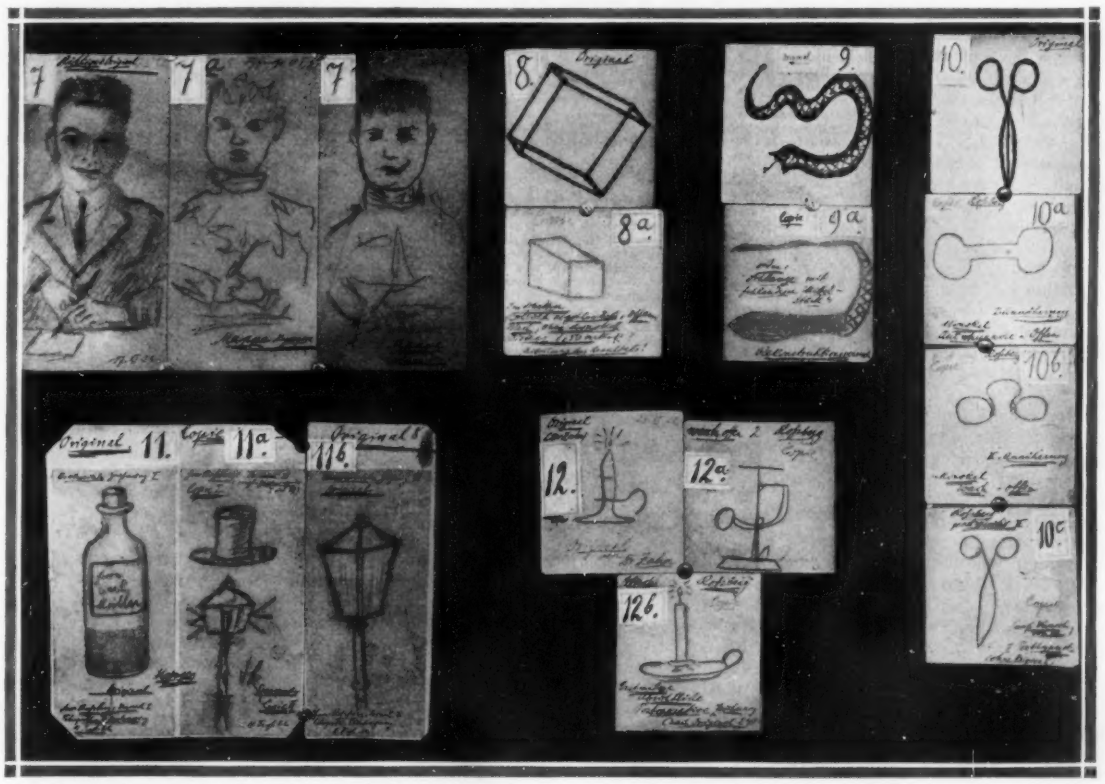
"Or finally, is it a psychic process arising from sources so far inaccessible to our understanding?"

Only in the event of telesthesia, as well as all other occult phenomena, being due to an exclusively cerebral function, would it be possible to adopt an exclusive psycho-physical viewpoint, or even on a purely physical basis to imagine radiations of some sort from the brain as carrier of the telepathic faculty. But this exclusively cerebral activity has not been generally acknowledged, even for the psychic phenomena of the conscious mind; and this lack of knowledge is clearly seen when Richet employs for the telepathic phenomenon in its entirety the term "crytesthesia"—a term which amounts in substance to a clearly stated *"ignoramus."* The number of original tests by those primarily fitted for the task is inadequate; the theory must therefore of necessity be inadequate.

In conclusion, a word should be said of the weak point met in all fields of psychic research—the absence of satisfactory results in control and demonstrative tests, which would not in all cases seem to be disposed of by the hypothesis of emotional psychic impediments such as often do make themselves felt. The fear of failure, inadequate mental contact with the subject, temporary absence of the usual experimenter, we know from the normal experience of normal psychology are likely to lead to failure. With many subjects, individual suggestibility is bound to bring about a condition of superpreparedness and enhanced telepathic productivity with regard to customary and sympathetic suggestions, which under other conditions may be lacking. In the case of Mr. R., despite a continuous excellent contact with him, a whole series of failures was often observed under what appeared to be the usual conditions. The intimate cause of such temporary psychic indisposition will not for the present be understood any further than, speaking generally, the similar temporary indisposition is understood in connection with all intellectual activity—and especially with artistic, inspirational activity. The fact is that all artists, both productive and reproductive, whose achievements are strongly emotional show just this periodicity of effective work.

The part, possibly in addition to conscious will and possibly not, assumed by feelings and emotions, sensations and perceptions, in telepathy as well as in other metapsychic phenomena, has yet to be ascertained. The exhaustion observed even by myself and sometimes by the very spectators toward the end of a test sitting, the feeling of disinclination possibly connected therewith, should to some extent account for the presence of temporary disability. Constitutive factors should doubtless be considered as well: puberty, marriage, climate, constitutional health and specific disease infections, possibly even a change in the social medium. The suggestion of good faith inherent in the variability of these, perhaps the most trying of all the phenomena of the mind, is far too strong to be thrown aside at a word from the thoughtless critic. We should expect success to be capricious; and we find it so.

AS THIS issue goes to the compositor, we are perfecting plans for an experiment of our own similar to Dr. Bruck's, but covering a very much greater ground. The experimenters will work from the WOR broadcasting station in Newark, and every member of the radio audience who is sufficiently interested may become one of the "subjects" by the simple process of listening in. We shall have the experimenters concentrate upon a succession of numbers, words, objects, pictures, etc., and we shall ask the "subjects" to try to get an impression of what these are, to record these impressions, and to report to us by mail. We should have a number of responses sufficient to make possible a severe statistical treatment of the results, which will be made public in the earliest available issue of the SCIENTIFIC AMERICAN*—that of June if the work of compilation is not too arduous, otherwise that of July.*—THE EDITOR.



Another series of tests in which the "telepathically" received impressions of the subject checked up well with the originals

Putting the Atom to Work

The Attempt to Isolate its Energy, and to Find How it May be Released for Human Use

By Sir Oliver Lodge, F.R.S.

THE atomic weight of hydrogen is not exactly 1, but by careful measurement is found to be 1.0077. Who could imagine that in this slight discrepancy—which indeed needs some explanation to make intelligible,—an immense store of possible energy is indicated, which some day, when we have learned how, may become accessible for good or ill to the human race?

Let us first expound the meaning of the statement. For the bare statement that the atomic weight of hydrogen is 1, or nearly 1, conveys nothing whatever unless we know the unit in which it is measured, that is to say, unless we have something to compare it with. For of course all measurements are relative to something.

Well, it so happens that rather more than a century ago, viz., in the year 1813 (when the atomic theory of Dalton was ten years old), Prout made the observation that the atomic weights of all the elements, as then ascertained, on the basis of taking hydrogen as 1, were too nearly whole numbers to be the result of chance; and accordingly made the suggestion that the outstanding discrepancies might be otherwise accounted for. He surmised that they really were whole numbers, and not fractions, so that possibly all the elements were multiples or aggregates of hydrogen.

The hypothesis, after exciting some interest, went into disrepute for a long time; though admittedly a great number of the atomic weights, as determined by chemists were very close to whole numbers. But there were a few exceptions that could not be overcome, of which the most notable was chlorine, whose atomic weight was unmistakably 35½; and no contrivance could make it 35 or 36. If it had been like potassium 39.1, or like iodine 126.9, a little contrivance, or assumption of error in experiment, would have allowed these to be interpreted as whole numbers. And there were many of the atomic weights in this reasonable position. But there were some that were recalcitrant, not only chlorine, but say silicon, which was 28.3, and magnesium, which was 24.3. And the outstanding fractions were more than could easily be got rid of. Hence, though there was something admittedly puzzling about the near approximation to whole numbers, the hypothesis of Prout that all the elements could be built up of hydrogen, with the atomic weight 1, fell into discredit.

Nevertheless it was not altogether killed. For Sir William Crookes in 1886, at a meeting of the British Association in Birmingham, made a suggestion that perhaps the elements were not such simple and well defined things, and the atomic weights not quite so numerically definite, as had been thought; that what we call magnesium, for instance, might possibly not be a single substance but a sort of average, a certain proportion with atomic weight 24, mixed with another smaller proportion of atomic weight, say 25 or 26,—the proportion so adjusted that the combined weight should come out 24.3, or thereabouts. In other words that the experimentally determined atomic weights were averages rather than exact figures; though admittedly chemical skill allowed these averages to be determined with surprising accuracy.

It is worth while to quote Crookes's words in this connection, published as they were so long before any verification was possible. This is what he said:—

"I conceive, therefore, that when we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on."

This, when thrown out, was only a hypothesis, a guess, a suggestion. Or, as Crookes himself called it, "an audacious speculation." But, like many of Sir William Crookes's ideas, it was based upon an instinct not to be despised, and was worthy of such testing as might be possible. At the time, no such method was available. The discrimination of the constituents of elements, on the supposition that there might be such constituents, could not be done by purely chemical means. For presumably every constituent which grouped itself about the average value, though it might differ slightly in atomic weight, must have identical chemical properties. Otherwise they would have been separated long ago, and not called by one and the same name.

The possibility of the existence of such elements—of which the atoms differ in weight but in no other particular, having all their chemical properties exactly the same, and giving the same identical spectrum,—suggested itself to Professor Soddy, in connection with his work on radioactivity. And he called them *isotopes*, meaning that they occupied one and the same place in the chemical series of Mendelejeff. This idea may be dated as of 1910. Soon afterwards, in 1912 and 1913, a remarkable method of analysis by physical means in a vacuum tube was invented by Sir J. J. Thomson,—a method known as positive-ray analysis. And this was forthwith applied in an improved form by that indefatigable worker F. W. Aston (who went from Birmingham to Trinity College, Cambridge,) with remarkable and striking success, confirming to the hilt both Crookes's speculations and Soddy's half-ascertained results. The simultaneous communication of these vital discoveries, with the assured conclusion that atomic weights were really whole numbers and that all the fractional part was due to a mixture of different whole-number isotopic ingredients, was made to the British Association at Birmingham in 1913; one to the Chemical and one to the Physical Section, by Soddy and by Aston respectively, 27 years after Crookes had thrown out his suggestion in the same city.

Aston was able to show that chlorine, with its atomic weight 35½, or with greatest accuracy 35.46, was really a mixture, in unequal proportion, of two elements exactly like chlorine and occupying the same place in the periodic table, so that they could be appropriately called isotopes; but of which the atomic weight of one was 35 and that of the other 37, the proportions being about three of the lighter to one of the heavier elements. And again that silicon, with its atomic weight 28.3, was an admixture of two real elements, 28 and 29.

Not all the so-called elements are mixtures. Carbon, for instance is exactly 12, nitrogen exactly 14. Magnesium is a mixture of three, with atomic weights 24, 25, and 26. And argon, though most of its atomic weight is 40, seems to have a slight admixture of a similar substance weighing only 36.

But now on what scale are these numbers specified? What is the unit? Well the unit is such that shall make some one of these elements of simple constitution exactly a whole number; and the scale chosen is that oxygen shall be 16. Then all the others fall into place. On that scale carbon is exactly 12 and helium exactly 4. But, strange to say, hydrogen is not exactly 1, and no amount of contrivance can make it 1. It is 1.0077.

How then can we say that Prout's ancient hypothesis is substantiated, or that there is any probability in the idea that the elements can be built up of hydrogen atoms? All we can say, so far, is that they appear to be built up of some units which can be counted, and which only occur as integers, not as fractions. Whether this something is or is not a hydrogen atom remains for further exposition.

This exposition may be approached in two directions, both strongly confirmatory; one experimental, the other theoretical. Perhaps we had better take the experimental one first, as it is the simpler of the two.

The atoms are known to consist of massive nuclei surrounded by much lighter electrons. Practically all the atomic weight is in the nucleus. Even in hydrogen, which has the lightest nucleus, it is about 1850 times as massive as an electron. Whereas, in a really heavy atom like uranium, it is 92 times heavier still. Hence, when we speak of the atomic weight we mean the weight of the nucleus. And if the atom is to be built of hydrogen, it must be that the nucleus is so composed. No one imagines that the electrons have anything to do with hydrogen. Hydrogen is a positive nucleus with one outlying electron. And if the nuclei are composed of hydrogen, it must be of hydrogen nuclei tightly packed together, so as to form the compound nucleus of heavier atoms.

It was known that these nuclei were small compact things, and that they were positively charged; but very little else was known about them, until Sir Ernest Rutherford found a means of knocking them to pieces, and thus seeing what they were built of. The only way to attack them is by their peers. They could not be shattered or got at in any way by any such trivialities as high temperature, extreme cold, enormous pressures, chemical explosions, or anything of that kind. They were far beyond the reach of these trifling perturbations. But the projectiles fired off by radium, at a speed of several thousand miles a second, were not so insignificant. And Rutherford arranged to bombard the nucleus of any desired atom by means of these projectiles. They were targets excessively difficult to hit because they were so ultra-minute; and thousands of shots might go by them without achieving anything. But then hundreds of thousands of shots were available, any number in fact; so that sooner or later there was bound to be a hit. And then something happened. Briefly, the nucleus broke up, and hydrogen flew out of it. The evidence for this must be read in Rutherford's papers. The evidence is given for the propulsion of a quick-flying hydrogen atom driven out of the nucleus by the bombardment.

Well, this was pretty direct evidence that the nucleus contained hydrogen, or at least contained it in the same sense that water contains it. For hydrogen can be driven out of water by an electric current; in that case, it is true, a very perceptible or possibly a large amount, whereas, in Rutherford's experiments only one or two atoms are ejected. But we are accustomed to deal with atoms nowadays and to recognize them individually. And the evidence is sound. It does not prove that the atom is built of hydrogen and nothing else; but it proves that hydrogen is one ingredient. What else was knocked out of it? Atoms of helium. But we knew that atoms of helium were there before, at any rate in many atoms, for they are spontaneously ejected during radioactivity. Hence, it looks as if everything was built of hydrogen and helium.

So now we have to consider what helium is built of. Its atomic weight is four, exactly a whole number. Hence, if hydrogen were 1, we should have little doubt that it was built of four atoms of hydrogen, very closely compacted together. But the atom of hydrogen seems too heavy for that. It is not 1; it is 1.007. How can we say then that four atoms of hydrogen can by any possibility build an atom of helium?

Well, here comes the theoretical part of the exposition, the part which I said was rather hard. We have now to enter upon the electrical theory of matter. We know now that matter is electrically constituted, and that what we call its inertia is really due to the magnetic field of moving electric charges, that inertia is

(*Continued on page 358*)

THE series of drawings on the facing page, which we employ as illustrations for Sir Oliver Lodge's article, was obtained by Mr. Clatworthy, our artist, from Sir William Bragg's Christmas lecture before the Royal Institution. Fig. I represents the C. T. R. Wilson cloud condensation apparatus, in the glass chamber of which clouds are formed and dispersed as in nature. Its object (Fig. II) is to render actually visible the tracks of the atoms that shoot off from a radioactive substance, by condensing tiny globules of water upon these. To explain these varied tracks, one must understand the complex structure of the atom, as discussed by Sir Oliver and illustrated in Fig. III.

With a dummy billiard table (A, center figure) and numerous balls representing atoms, Sir William demonstrated the relations existing when one ball attempts to pass through the cluster, and demonstrated how empty the center of an atom must be to admit the passage of foreign electrons as it does. In the straight track of Fig. IV, the electrons have thus penetrated the air atoms; in the curved track of Fig. V nucleus has collided with nucleus, resulting in abrupt deflection.

The lecturer explained the relation between chemical activity and atomic configuration, the reasons why inert gases are inert, etc., but as Sir Oliver covers this fully in the present and a preceding article (SCIENTIFIC AMERICAN, November, 1923) we may pass it over here. Fig. VI is for the purpose of showing that the phenomenon we know as heat is simply one of atomic motion. The more a gas is compressed, the closer together its atoms lie and the more frequently they will collide—causing the manifestation of heat.

The reverse (Fig. VII, center) also obtains, a gas cooling under expansion.

In Fig. VIII, sound waves demonstrably pass between the atoms. Thus these waves travel more quickly in hydrogen than in the denser oxygen.

The pressure of a gas is simply the bombardment of the surrounding walls by its atoms. The atoms of a gas can also obstruct those of a solid (Fig. IX), or of a liquid (Fig. X). In a solid, the constituent atoms are firmly united; in a liquid they are in touch, but not permanently, for they change partnership continually; whereas, in a gas all the atoms move about independently and arbitrarily.

THE INTERNAL MECHANISM OF THE ATOM, AS DEMONSTRATED AT A RECENT LONDON LECTURE

Our Point of View

The Mischievous Pen

THE World War tumbled emperors from their thrones and placed the destinies of nations more directly in the hands of the people. A desirable change, provided the masses are kept fully instructed on matters of domestic and foreign policy. Under the old order the potentate was well informed, particularly on the international situation. His embassies and secret service saw to that. Today, the masses, the great body of the voting population, are dependent for their knowledge of world affairs upon the press; and more particularly upon the special correspondent and the so-called special writer.

In former days the emperor "rattled the saber"; today the press rattles the pen. Our war-stricken world understands, only too well, what evils may come of saber-rattling; and unless the owners of the great journalistic organs of the day muzzle their correspondents, the world will find out, to its infinite loss and agony, that the pen as a breeder of war, may be even "mightier than the sword." But would you have the owner of a great daily muzzle his staff? Most assuredly we would, to the extent of his laying it down as a law never to be broken, that the correspondent, special writer, or what-not shall deal in facts only and not in his own sensational and war-breeding interpretation of the facts.

Of a vast number of the people it may be said that, once they have left the public school, their sole source of education is the daily newspaper. They read nothing else; unless it be an occasional novel from the nearest Carnegie library. And such people (whose ordered education ceased with the public school) have a pathetic faith in the infallible authority of the press.

"I saw it in the paper"—and that settles the matter. Hence the masses of mankind are made to believe that Japan dreams of capturing our Pacific coast; that France aims at the military domination of Europe; that Germany has secretly re-armed herself with a huge aerial fleet and is ready to drench Europe with poison gas. The King of Spain pays a friendly visit to the King of Italy, and forthwith your European correspondent pictures a new European bone of contention—the control of the Mediterranean. The Caliph is expelled from Constantinople; next day you are assured that Great Britain would have an Arabian Caliph, France a Moroccan, and that herein lies another cause of friction and ultimately of war.

Helium as a Life-saver

A CORRESPONDENT very properly takes us to task for not having mentioned, in our recent article on the "Shenandoah," that she uses helium instead of hydrogen. The omission was due to familiarity; to think of "Shenandoah" was, for the writer, to think of helium and, so, familiarity bred not contempt but omission. As a matter of fact the writer considers that the most distinctive feature of the ship is the helium that lifts and supports her. To this remarkable gas she owes her great superiority over all other airships. She cannot be rent asunder by explosion; nor can she suddenly be converted into a flaming funeral pyre for the whole of her officers and crew. To realize what this means we have only to call to mind the horrible fate of "ZR-1" at Hull, England; of "Roma" at Hampton Roads; and of "Dixmude" off the coast of Italy.

Lightning destroyed the "Dixmude"; sparking, of static or broken-wire origin, set fire to the other two; and it is a fairly safe guess that, had "Shenandoah" been filled with hydrogen when she was torn from her mast, there would have been another holocaust to record. For when the ship broke loose, several things happened simultaneously. Not only were a dozen longitudinal girders torn asunder, but the steel landing cables and their winches were pulled out of the ship and the two forward gas bags were torn open. The violent rupture of all this metal work must surely have been accompanied by frictional sparks and this occurring in the presence of liberated hydrogen would probably have resulted in fire or explosion, or both. Surely it is not claiming too much to say that it was her helium that saved "Shenandoah" and her crew from instant and overwhelming disaster.

Against the advantage of safety is to be set the scarcity and cost of helium and the fact that its lifting capacity is about 7 per cent less than hydrogen. The operating losses of the gas may be reduced by recovering the water from the engine exhaust, and maybe, though this is at present impossible, by some method of compressing the gas into cylinders instead of venting it into the air.

The Good Old Times

THERE is a romance about the past which finds expression in the phrase "the good old times." But, outside of their leisurely ways as compared with our modern rush, are we sure that these old times were so very good? Listen to the following, culled from our contemporary *The Engineer*, which refers in a recent issue to an address, given in 1864 by the President of the South Wales Institute of Engineers, when that gentleman described the shocking conditions attending coal mining in Scotland prior to the year 1800. It seems that the collier left home at eleven in the evening and prepared the coals by "hewing them down from the wall." His wife and daughters followed him three hours later, and descended the pit with baskets, which they filled with coal and carried on their backs to the pit bottom, the mother going first with a lighted candle held between her teeth. From the pit bottom these women carried their loads up the steps to the surface, and in eight to ten hours' time one woman might carry through the mine and up to the surface a total load of two tons, traversing a distance of nearly six miles, and climbing one hundred feet by the stairs, 24 times in succession.

Such were the good old times of the middle of the eighteenth century, when a man was hung for stealing a sheep and lesser infractions of the law were rewarded on the same ferocious scale. If the thoughtful among us speak of the good old times, it is because we are conscious of the high pressure and unending strain of our highly industrialized civilization. In such a mood one may long for the comparative quiet and restfulness of far-away days. But what would Shakespeare have to say, if we could bring him back to life; take him into the subway jam during the morning or evening rush hours; and let him be catapulted by the center rush into a tightly-wedged mass of humanity in an Interborough car? Or let us bring the great Dr. Johnson from his London Coffee House, and take him for a stroll down Broadway in the closing hours of the Wall Street district. "Sir," he would say, "I have turned over many an anthill with my boot, and seen no stream of insects to equal in numbers and density this outpouring of humanity from your Brobdingnagian buildings. Whether in play or at work, you swarm as do the bees; and of distinctive individuality I see no very marked signs."

Panama Canal Sufficient

WE have had occasion to point out the fallacy of claiming that because of the recent rapid increase in the traffic passing through the Panama Canal, the United States should begin to consider the construction of a second canal, preferably at Nicaragua. It is questionable whether Nicaragua would prove to be the most desirable location. The great length of the route and the engineering difficulties arising from the topographical conditions, to say nothing of its nearness to the earthquake zone, combine to cast a serious doubt upon such a project. The cost moreover would be prodigious.

To tell the truth there is no question of the ability of the Panama Canal to take care of future traffic for many decades to come. In spite of the gratifying growth of traffic, the canal as it stands has a wide margin of capacity. Even under its present limited hours of operation there is room for considerable increase in shipping; and when it is thrown open for night traffic, and is in service for the whole twenty-four hours of the day, its capacity will suffice for any probable increase in the near future.

When the time comes for enlargement of facilities, it will not be necessary to go elsewhere. By building an additional pair of locks, adjacent to those at Gatun, Miraflores and Miguel, and building a new reservoir at Alajuela, in the upper Chagres river, the capacity of the canal of that day may be doubled, and all anxiety for the future removed to a far distant day.

The recent remarkable increase in the tonnage passing through Panama has been due, mainly, to the opening up of certain very rich oil fields, mainly in California, and the fact that the oil can be carried to the Eastern refineries via the canal more cheaply than by any other route. These western oil fields have about reached the peak of their production; and future canal traffic may be slowed down by the withdrawal of these tankers.

The Oil Delusion

THERE is no money in oil (now please do not get excited), except for the very few. This is a startling statement and we would not make it except upon the best authority, which in this case is the U. S. Geological Survey. As their leading geologist said to the Editor the other day "Oil producers, as a class, lose money; though some make lots of money," and he went on to say, "that, by and large, including the 'wildcat' ventures, it costs more to get oil to the customer than the customer pays."

Consider the State of Oklahoma, where, a few weeks ago, oil was sold at $1.75 per barrel. To begin with, the prospective millionaire must pay out on an average $40,000 for drilling his well, and it will cost him about 15c per barrel to raise the oil during the flow. Pumping, on an average, will cost him from 80c to $1.00 per barrel. He must reckon in the interest on his investment of $40,000; and the well must pay its share in the general overhead of the company. Also it must pay its share of the original cost of the lease. Finally, all of the above items have to be taken from seven-eighths of the oil, since one-eighth, let us say, of the oil goes to the lessor. This estimate of seven-eighths of the oil to the operator is very liberal; for in some cases the terms may be drawn on a basis of as high as one-fifth of the oil to the lessor. By the time these costs have been deducted from the $1.75 received for the oil, we are prepared to believe that the "money from oil is made from the crude at the well on to the consumer."

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Here and There

SOME months ago we saw statistics indicating that the number of cars stolen each year in a group of leading American cities exceeds the total number in operation in countries as important as Japan and Czecho-Slovakia—several others were named, but these two alone we remember. We decided at the time that this was the most picturesque and convincing demonstration that ever had been or ever could be made of the unchallenged place of the United States at the head of the motoring world, and that we should never again try to illustrate this point by any other citation of figures than this one. So in the presence of the latest automobile census, as of 1923, we remark merely that there are today, by closest count and estimate possible, 18,241,477 automobiles in use throughout the world. It's a mighty big oak that has grown from the acorn planted two decades ago by Messrs. Ford, Olds, Haynes, Duryea, Rolls, Panhard, et al. Among the foreign nations, Great Britain has 655,000 cars; Canada 643,000; and France 460,000. In three others—Germany, Australia and Argentine—the totals exceed 100,000.

DURING the coming summer, Mars will come within 31,000,000 miles of the earth, something like 20,000,000 miles nearer than is his custom, and his closest approach in more than a century. Naturally, the astronomers who are interested in the details of the Martian geography are preparing to take advantage of the occasion; and a lot of people who cannot discharge their minds of the suspicion that Mars may be inhabited are getting as excited as could be expected over the prospect of proving their case. For ourselves, the question of communication with Mars leaves us absolutely cold. Whatever the attempt might cost, from ten cents to twenty million dollars, we could very easily spend in a better scientific cause.

THE dinosaur eggs which occupied the front pages of the newspapers, and one of the inside pages of the SCIENTIFIC AMERICAN, not so long since, are not the only prehistoric things of their kind. South Dakota now comes to the fore with a collection of fossilized eggs, turned up in her "bad lands" by Professor H. W. Nichols, assistant curator of geology at the Field Museum, Chicago. These are very much smaller than the dinosaur eggs, being the production of a small bird, apparently bearing some resemblance to the duck of today. The photographer who supplies Professor Nichols' picture qualifies for honorable mention by informing us these duck eggs are believed to be older than any other relic of animal life now existing, with the exception of the dinosaur eggs from "Magnolia." As a photographer, however, he is reliable; despite his weak geography, we have no hesitation in presenting his print as really representing the face of Prof. Nichols!

Prof. H. W. Nichols

ONE of the most active inventors among the scientists of the day is the sharp-faced individual at the lower left corner of the page—Dr. William W. Coblentz of the Bureau of Standards. If Dr. Coblentz were to be characterized professionally, it would probably be as an astro-physicist. One of his particular specialties is the study of the heat radiated from the stars and planets; and in this field he has devised most of the standard instruments now in use. The photograph shows him squinting into the eye-piece of a radiometer so sensitive that it will detect the heat given off from a candle at a distance of three miles. Is it any wonder that with such an apparatus, Dr. Coblentz can measure the heat which we receive from individual stars? We rise to remark that the Doctor carries his fifty years very well, if one may judge from his picture.

Dr. W. W. Coblentz

ALLUSIONS to the siege of Troy are contained in inscriptions on ancient clay tablets dating back a dozen centuries before Christ, according to German investigators who have these tablets in charge and under examination in Berlin. The tablets, brought from the Hittite country by Hugo Winkler, are 11,000 in number; and while not completely deciphered, have given up enough proper names to lend support to the theory that they deal with Troy and other Homeric topics. In addition to the famous siege, it is believed that the tablets include texts of treaties and other historical matter of prime importance. Our informant does not specify, but we presume that the language is that of the Hittites, which up to this date has defied all efforts at translation by modern scholars.

Prof. Elihu Thomson

THE Lord Kelvin Gold Medal for 1924, has been awarded to Professor Elihu Thomson, one of the world's most eminent electrical engineers. Professor Thomson is the first American to receive this award, which is made every three years as a mark of distinction in original research work in engineering. Professor Thomson got an early start in his profession, and was one of the moving spirits in the old Lynn, Mass., shops which later formed one of the integral parts of the General Electric combine. Professor Thomson's inventions in dynamo-electric machinery, electric welding, watt-hour meters, lightning arresters and magnetic arc extinguishers are fundamental; and in all, he has been granted about 700 United States patents. He was a pioneer in arc lighting, and innumerable electrical devices have been improved through his work. In addition to his research work, he has always been active in educational circles, having started in the Central High School of Philadelphia, and being now identified with the Massachusetts Institute of Technology. The Lord Kelvin Medal is merely the latest of numerous similar honors which have come his way.

NUMEROUS are the ambitious souls who visualize the immediate commercialization of the airplane upon a large scale, so that regular passenger service between New York and San Francisco, London and Australia, Paris and the heart of Africa, may be looked for by nine o'clock tomorrow morning at the very latest. Well, we have the many short lines in Europe, of which those crossing the Channel are apparently the most prosperous; but when the distance covered begins to run up into the hundreds of miles, the commercial difficulties of the promoters begin to outstrip even the technical ones. Thus, the British Government has just gone on record as refusing to back a project for service to India and Australia, and as a result the promoter has had to abandon his scheme. Those who have contemplated trusting their money to such projects as well as those who would contemplate trusting them with their lives, can well afford to look upon them more conservatively than is the custom. The plain facts are that we are not ready for long-range airplane service on any more ambitious scale than that now followed by Uncle Sam in his transport of mail, and it will be an indefinite period before we are ready. For long distances, it seems a safe prediction that the airship will precede the airplane in the successful commercialization of aerial navigation.

Prof. Arthur B. Lamb

ONCE upon a time, in telling the tale of modern industrial chemistry to the layman, it was necessary to start with an explanation of why ammonia is one of the most essential of all manufactured chemical products, and a cornerstone of all chemical industries. Today we assume that the general reader knows so much, and we tell each story of further advance in the production of ammonia on its own merits, without reference back to the general problem of nitrogen fixation. Prof. Arthur B. Lamb, director of the chemical laboratory at Harvard and of the Fixed Nitrogen Laboratory in Washington, is the latest figure in the ever-progressing attack upon this problem. He has discovered a new catalyst—its chemical identity is not yet revealed—which will bring about the direct union of hydrogen and nitrogen, yielding among other products the precious ammonia, and in larger amounts than by older processes.

THE subject of catalysis itself is one of chemistry's romances. Dr. Hendrick has called the catalyst the chemical go-between. Perhaps an equally pertinent analogy would be to call it the chemical lawyer, or even the chemical court of domestic relations. Two prospective litigants who simply cannot agree may—if the lawyers are the right kind—manage to agree through their lawyers. Two persons who believe it utterly impossible to live together in harmony find, in the presence of the skilled adjuster of domestic entanglements, that it isn't impossible after all. And two chemicals that will have nothing to do with one another, under ordinary circumstances, if brought together in the presence of a third substance, will perhaps form a perfectly good union. The lawyer isn't used up, the judge isn't used up; both are available to bring about subsequent reactions. And the catalyst isn't used up, either; it stays in the retort, while batch after batch of raw materials are put in, and batch after batch of the finished product taken out. Platinum is one of the best known of catalysts, but there are plenty of others, and it is one whose catalytic properties have heretofore been unknown that Professor Lamb has unearthed.

WE ARE rather in the habit of looking upon the modern city as the haunt of man alone, and assuming that wild animal life must necessarily be confined to the rural sections. It is of course true that the game animals shun the residence of man; but none the less we have a very considerable spontaneous animal life in our cities, and this uncensused fauna makes its presence objectionably felt from time to time. "Huge Rat Bites Sleeping Infant and Fights Man"—so reads the headline of the morning paper this fine day in March. The text is not confined to the specific instance of the head, but quotes a Health Department official to the effect that the war against rats is hopeless. He estimates that New York has a rat population of 3,000,000; that no more than 22,000 of these rodents are killed annually by human agency; and that next to the fire hazard, they constitute the greatest single source of property loss in the city. Mice and tramp cats are just two other examples to show that our cities are not quite so exclusively given over to human habitation as we are habituated to thinking. Nor is it at all unusual for these and other, ordinarily shy, species, to display very keen fighting capacity when cornered, so that it is by no means a hyperbole to speak of the wild animal life of our cities.

The Story of Steel—V

Bessemer Converter, Where Air Performs the Major Process in Steel Making

IN chapter IV of the Story of Steel, we saw that in the blast furnace iron was separated from iron ore by means of the fierce heat resulting from the combustion of coke, through which great volumes of heated air were continually being driven. The resulting metal, as it is tapped from the bottom of the furnace, is liquid cast iron, or "pig" as the furnace man calls it.

Now, although cast iron is a useful metal in the constructive arts, its range of usefulness is greatly limited by the fact that, though its compressive strength is high, its bending and tensile strength are low. It lacks the ductility, toughness, elasticity, and all-round strength of steel. The absence of these qualities is due to the excessive amount of carbon present, as compared with that in steel. There is also an excess of silica, a constituent of sand and rocks; phosphorus, as used on the household match, sulfur, which the "kiddies" used to take (and may do yet, for all we know) in "sulfur and molasses," and manganese.

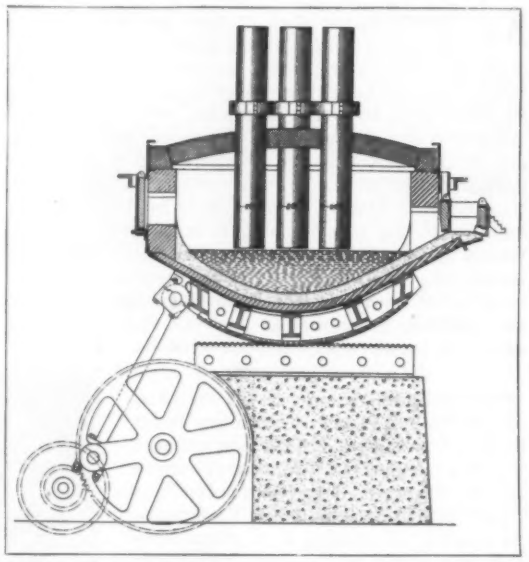
And as fire is used to get the iron out of the iron ore, so fire is used to turn the iron into steel. This it does by burning out the above-named impurities, either in the Bessemer Converter or in the Open-Hearth Furnace. The Bessemer Converter, developed in England by Henry Bessemer about 1855 was an epoch-making invention in the steel industry. By many, because of its revolutionary effect on modern industry, it is regarded as the greatest of all inventions; for without it the production of cheap steel in unlimited quantities would have been impossible. It was admirably adapted to all ores that were low in phosphorus content. As the choicer ores became depleted, the open-hearth furnace of Siemens-Martin was developed; and in this furnace ores that are high in phosphorus can be treated successfully. Today, about 25 per cent of the steel is made by the Bessemer and 75 per cent by the Open-Hearth method.

Steelmaking, as the editor recently saw it, is highly spectacular all the way from the vast open mines at Missabe to the rolling of the steel into its thousand-and-one shapes in the mills; but nowhere does it present such a dramatic and awe-inspiring sight as in the converting mill.

The converter is a barrel-shaped steel vessel, varying from 10 to 16 feet in interior diameter, and from 12 to 20 feet in height. It is closed at the bottom, and is drawn in at the top, as shown in the sectional view on the adjoining page. At its mid-height it is supported on trunnions. An air pipe is led in through one of the trunnions and continues down to an air chamber in the base of the converter. The interior is lined with 12 to 18 inches of refractory material to protect the steel shell from the fierce heat. The bottom is perforated with from 150 to 200 one-half-inch holes, leading from the air chamber to the interior of the converter.

Now let us return to the blast furnace. Here, at intervals of every four hours, the clay plug which seals the outlet from the bottom of the furnace is broken through and the molten iron is run into a train of steel ladles, which are drawn by a locomotive to the mixer, a large horizontal cylinder, lined with firebrick, which can hold 1300 tons of metal at one time. The mixer here spoken of is part of the plant of the South Works, Chicago, of the Illinois Steel Company. The object of the mixer is to form a large reservoir, from which the hot metal can be drawn as required by the converters.

From the mixer the hot metal is emptied by rotating the mixer on its axis, and pouring its contents into ladles for transport to the converters. The converter is turned down into a horizontal position, and a charge of 10 to 25 tons is poured in from the ladle. The air blast is then turned on and the converter swung back into the vertical position. The air, under a pressure of about 20 to 25 pounds to the square inch, is now forced up through the molten iron in from 150 to 200 separate streams, and its oxygen, combining with the carbon, silica and manganese in the iron, sets up a violent combustion, and raises the temperature of the mass until it reaches the stage known as the boil. The process continues for from 10 to 15 minutes, at the close of which all of the impurities and practically all of the carbon have been burned out and only pure iron remains.



Section through the electrical furnace shown below. The current passing through the three 20-inch electrodes and the metal charge raises the temperature to as high as from 2850 to 3000 degrees

The oxygen of the air first burns away the silica and manganese and finally the carbon. The color and density of the flame issuing from the mouth of the converter clearly indicate to the skilled operator what is going on inside. As the silica and carbon begin to burn, an orange-yellow flame, edged with blue, streams from the nose of the vessel. Then, as the carbon begins to burn there is a change to a bright flickering flame which rushes violently forth, accompanied with great streams of sparks. Then the flame dies down. The process lasts only from 10 to 15 minutes; but the fierce combustion raises the temperature of the metal in that short time from 2000 degrees to as high as 3000 degrees.

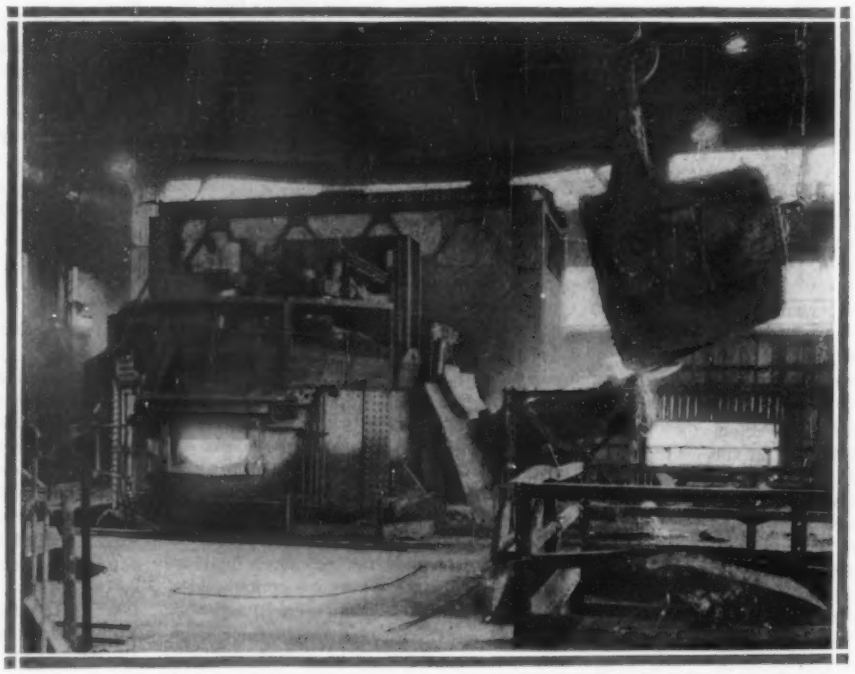
We have spoken of the spectacular effect afforded by a converter mill in full blast. The agitation of the molten mass, as the air mashes through it, produces a dull reverberation, which mingles its deep note with the steady roar of the hot and brilliantly colored gases, as they pour from the mouth of the converter. Every now and again small particles of white-hot metal are thrown high into the air and fall in a thick rain of brilliant coruscations to the ground. A good impression of these effects can be gained from the colored cover of our April issue, which shows a converter in full blast.

But the mere burning out of the undesirable elements does not give us steel; for what we have left in the converter is merely an unadulterated and "characterless" iron. It must now be changed into steel by putting back into it, with great exactness, a certain amount of carbon, manganese, silica or other substances to produce the kind of steel required. Accordingly, after the converter is turned over and before its contents are poured into a ladle, a carefully weighed amount of these substances in the form, let us say, of spiegeleisen, is introduced in molten form into the converter, to give the small amount of manganese, silica and carbon required in the finished steel.

The ladle is now lifted and a train of cast-iron ingot molds, with two or three molds to the truck, is drawn beneath the "pouring stand," and the steel is run into the molds through a nozzle in the base of the ladle.

The Bessemer converter has been replaced very largely by the basic open-hearth furnace, which is capable of handling satisfactorily iron made from inferior grades of ore containing large percentages of phosphorus. The Bessemer converter does its work upon the metal in from 10 to 15 minutes, whereas the open hearth requires from seven to 12 hours. Speaking broadly, the open-hearth process permits the metallurgist to keep in closer touch with the reactions that are going on within the furnace, and, by skillful treatment, he is able to secure with accuracy the exact amounts of carbon, manganese, etc., necessary to give him the steel which he wishes to produce.

Excellent as the open hearth furnace process is, the steel maker has aimed to get even better results by using the electric arc as his source of heat in the furnace. Much experimental work has been done, and out of this has come the Heroult electric furnace, of which we show a photograph and cross-section on this page. The Illinois Steel Company have been very accurate and successful in the development and use of electric refining, and the two 25-ton furnaces shown in our photograph are among the largest and most successful in existence. The United States Steel Corporation has four of these 25-ton electric furnaces, and the Corporation built two 40-ton Heroult electric furnaces for the United States Navy, which operated very successfully during the war at the U. S. N. Ordnance Plant at So. Charleston, W. Va.

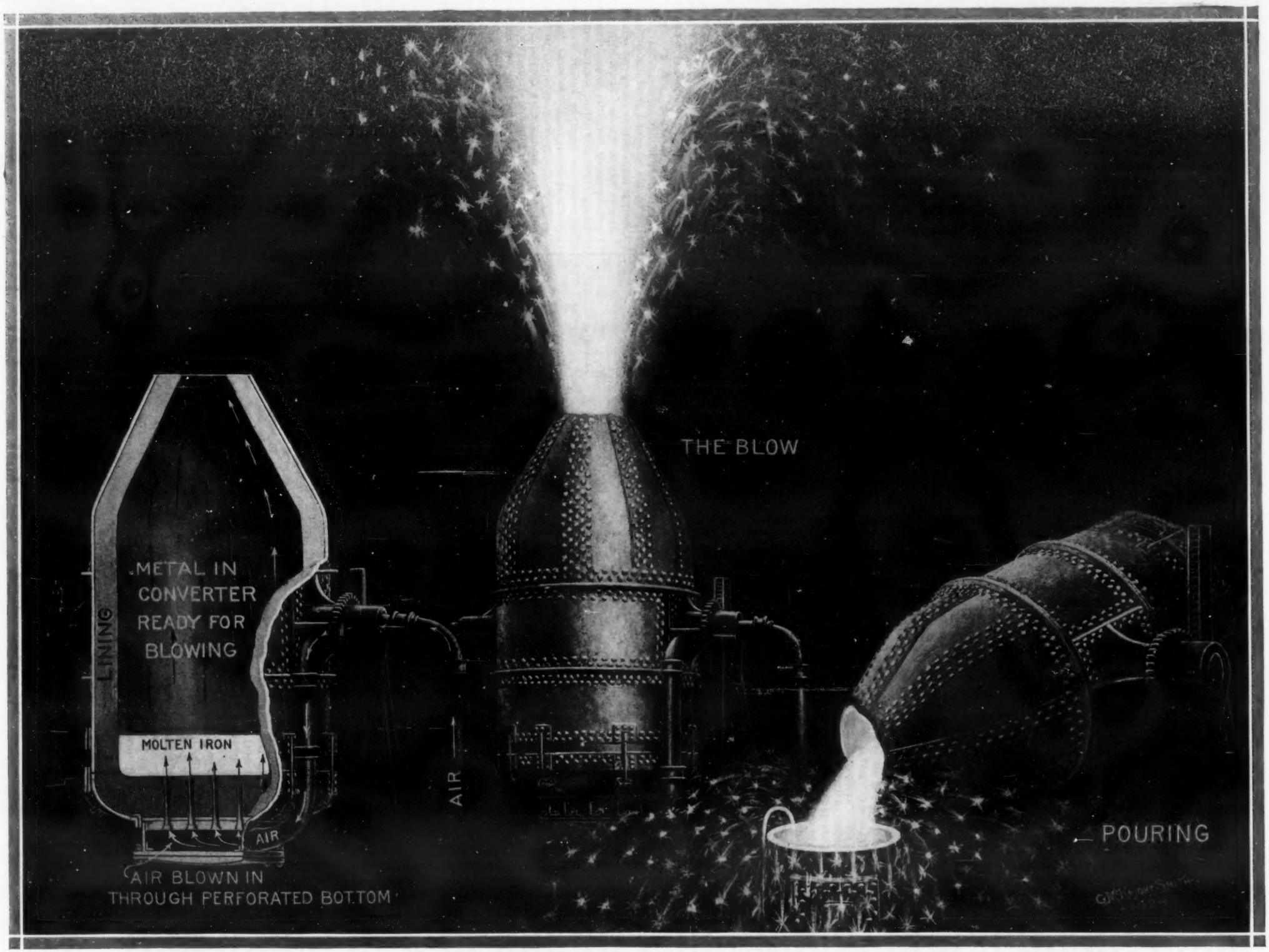


To the left is a 25-ton electric furnace; to the right a ladle is discharging molten iron into the furnace for treatment

The furnace, 16 feet in diameter, has a plate-steel shell one inch in thickness. The bottom is carried on toothed rockers and tracks, on which the furnace is tilted to empty its contents. The large wheels shown are geared to a 140-horsepower motor, which tilts the furnace, by means of a connecting rod. The furnace is lined with three different materials; first 4½ inches of fire-brick; next to that a lining of magnesite brick 9 to 13½ inches in thickness; and above the last named is spread about 13 inches of dead, burned magnesite. The dome-shaped roof, 12 inches thick, is of silica brick.

In the roof are three equally spaced openings for the electrodes, 20 inches in diameter, which are formed of amorphous carbon. They are carried by horizontal arms that project over the furnace from heavy, vertically moving rods. Heavy copper cables and copper bars carry the current from

(*Continued on page 366*)



IN THE BESSEMER CONVERTER STREAMS OF AIR ARE BLOWN THROUGH THE MOLTEN IRON, BURNING OUT THE SILICON, CARBON, MANGANESE, ETC.—THE MAJOR STEP IN CONVERTING THE IRON INTO STEEL

When, Where, Why?

How Connecticut Gathers the Data of Her Automobile Accidents, and the Use She Makes Thereof

By the SCIENTIFIC AMERICAN *Staff*

OUR consideration of the automobile traffic problem has been centered, to date, upon the question of uniformity of law. But this is far from the whole story. In the end, the traffic problem is entirely a matter of accident prevention; for if there were no accidents we should be unconscious of any problem. Now uniform laws would be of great value in preventing accidents; but the accidents that occur are of such various sorts and arise from such various causes, that neither this nor any other single measure, however desirable and important, will prevent them all. In view of this complexity, the first step in accident prevention is to come to a thorough understanding of the ways in which, the circumstances under which and the reasons why accidents occur.

If we are thus to attempt the collection of data regarding accidents, we must get it, in the first instance, from the people to whom the accidents happen. In most cases, one or more of the parties to an accident has a motive for the suppression of facts. Hence it is obvious that we can get at the facts only under the authority of the law, through agencies established by the law, and with the distinct backing of the law.

Reverting for the moment to the uniformity theme, we find that our several state codes show the widest divergence in the extent to which and the way in which they provide for official examination of accidents. Of a handful of motor-law pamphlets which we select mainly on the ground of the easy accessibility of their contents, those of New Hampshire and Minnesota appear to make no demands upon the parties to an accident. Idaho, Maryland, South Carolina, Nebraska and California require only the giving of any necessary assistance to the other fellow, plus the exchange of numbers, names, addresses, etc. Oregon demands that the recipient of such information make a written memorandum of it—a useful idea; Washington is unusually explicit in forbidding either party to move from the spot before establishing his identity.

Numerous states go further than this. To the requirement of identification, Kansas adds the demand that, "in case of death or serious injury," resulting from the accident, report shall be made to the nearest police or peace officer; but one wonders where one's responsibility for knowledge that "serious injury" has been inflicted begins, and one wonders also how to interpret the provision that the person "causing" the accident do the reporting. Utah's law is much clearer, making it obligatory upon *all* the drivers involved to report, in all cases resulting in personal injury *of any sort*. New York makes the same demand, in very precise language, of all those involved in an accident that results in personal injury or damage to a vehicle. Illinois attempts the same thing. But where New York explicitly requires the exchange of identifications in addition to the report, Illinois seems to give one the option between telling the other driver and telling the police. Massachusetts, Rhode Island and Connecticut have substantially identical laws which carry the examination of accidents by official action to its climax. We quote the statute of the Nutmeg State.

"The operator, whether resident or non-resident, of any motor vehicle involved in an accident resulting in personal injury or damage to property to an apparent extent in excess of ten dollars, within twenty-four hours thereafter, shall make a written report of the circumstances thereof to the Commissioner of Motor Vehicles and shall supplement such report by a detailed statement, under oath, on blanks to be provided by the Commissioner, which shall be as nearly accurate as may be ascertained and shall state the time, place and cause of such accident, the injuries occasioned thereby and such further facts as the Commissioner may require. The Commissioner may make such investigation of such accident as shall seem to him advisable, and for such purpose he may require the assistance of the state police. The Commissioner shall take such action as may be necessary to enforce a strict compliance with the provisions of this section." This statute would be improved by a specific requirement that each driver establish his identity with the other, and a really skillful punctuator could distribute the commas in such a way as not to value personal injuries at ten dollars, up; but in the large rather than in such detail suggestion for betterment goes by default.

The necessity and the utility of such close official pursuit of those involved in a motor accident will not often be questioned. If the practice were attacked, however, no better means of supporting it would be available than a thorough examination of the entire procedure in Connecticut—a survey of just how the Commissioner collects these accident data, and of just what he does with the information after he gets it.

If you have an accident while driving in Connecticut, the law contemplates that you will so report to the Commissioner; and by return mail you get a blank to fill out. If you don't report, the other party to the smash probably will; and then your goose is cooked. For it takes two reports to complete the Commissioner's file on an accident, and if the second isn't forthcoming, he goes out and gets it! The police and the casual witnesses afford another means of checking up; and one of the young ladies in the Commissioner's office clips a large number of accidents from the papers of the State, and every once in so often a failure to report is uncovered in this way. The probabilities of your getting away without reporting, in the end, are very slight; and of course a late report or a reluctant one is a bad one upon which to rest your defense, not to say a word about the fine.

The numbers that represent the accidents occurring at each point are on pins, those up to five having triangular heads and those beyond square heads; plain round heads show, independently, fatal accidents. Similar maps are kept for all the large cities of the State

A year's (1923) traffic accidents in New Haven, as tabbed in the office of the Commissioner of Motor Vehicles for the State

When you get your blank, your are confronted with a regular income-tax-return proposition. Under the head of general information you are asked for the complete address and exact location of the accident. You are asked to choose between ice, wet, good, snow, rough, mud, and sand as characterizing the condition of the road surface at the time; between straight, curve, uphill, downhill and intersection as describing the shape of the road; and between clear, rain, snow and fog as describing the weather. You are asked the date and the hour; and you are given the choice between trolley, railroad train, team, bicycle, pedestrian, fence, telegraph pole, road obstruction or another automobile as the thing with which you got tangled up.

Next, about your own car. Name, age, sex, address, number and date of operator's license; and did you have it with you? If under instruction, give these details about the licensed operator who was with you. How many years have you held Connecticut license? Did you operate car as owner, or as employee or friend of owner? How long have you operated this particular car, and when did you last test its brakes? Were you operating for hire, business, or pleasure? Give registration number, make, type and year of car, with owner's name and address. State condition of brakes and horn, make of lens, and character of lamps (electric, gas or oil). Estimate the extent of damage to the vehicle, and describe said damage.

You are not expected to know quite so much about the other fellow's car. Name, sex, license number and address of operator; name of owner; make, type and registration number; condition of brakes so far as you know; appraisal and description of the damage to it. Then you are given a place to tell who was hurt, and how, and to estimate and describe property damage other than to the vehicle. If a third vehicle was involved, there is space to tell about it, too.

Then there is a place to give the name and rank of any police officer present at the scene, to state who was arrested or summoned (the ordinary police jurisdiction over the accident itself is in no way impaired by the Commissioner's investigating powers), and to record the names and addresses of the witnesses. The text of the blank duly impresses upon you the necessity of getting a complete collection of these names.

Finally you are asked to indulge in literary composition to the extent of not more than ten lines, giving the circumstances surrounding the accident—"state when you first realized that an accident would happen, and give in detail how it happened and what occurred after it." Six characteristic road lay-outs are printed in outlined diagram—a straight stretch, a curve, a square cross-roads, an oblique one, an offset square one, and a Y-fork; and on one of these, or on a fresh one made to order if none of them applies, you are invited to diagram the accident, using conventional symbols for a car or truck, a team, a motor- or foot-bicycle and a pedestrian, and indicating direction of travel. Then you sign, swear, and mail it to Hartford.

Now it is obvious that, from the viewpoint of fixing civil and criminal liability for this particular accident, there is a big advantage in thus getting a statement of facts upon official record. But from the viewpoint of the Commissioner's office, such advantages, large as they are, are quite secondary. The thing that makes this reporting of accidents valuable is the complete statistical record which it affords of the accidents that disfigure Connecticut's highways in the course of the month or the year. This record turns in several directions, and we must follow it a short distance in each of these directions if we are to understand the value of the reporting system in *preventing* accidents.

For one thing; you will recall that the parties to an accident must report the years in which their machines were manufactured. As a result of this, Commissioner Stoeckel is able to state categorically that old automobiles are more frequently involved in accidents than new ones; and the older, the more frequently. This at once suggests that the new driver is not responsible for so large a proportion of our automobing woes as we have ordinarily supposed; and that we may go too far in harassing him in his efforts to learn. More important than that, it suggests to Commissioner Stoeckel that he will ultimately have to ask authority from his legislature to inspect cars, and to rule off the roads those which are in such condition as to jeopardize other

(*Continued on page 360*)

Our Abrams Investigation—VIII

The Report of a Test on Localization of Abscessed Teeth Through Handwriting

By Austin C. Lescarboura

Secretary to the SCIENTIFIC AMERICAN Abrams Investigation Committee

ONE of the numerous startling claims made for the so-called electronic technique is the ability to "localize" diseased conditions. That is to say, given a drop of blood or even a specimen of handwriting, the skilled electronic diagnostician should be able to tell not only the cause of the patient's run-down condition, but also the point in his anatomy that is affected. Thus it is by no means uncommon for an electronic diagnosis to include some statement as to the localization of a pathological condition; there may be a specific reference to a certain abscessed tooth, an infected tonsil, a certain cancerous growth, a spotted lung, a marked syphilitic outbreak at a definite spot on the skin, and so on. Many are the stories told of wonderful localization of various diseases by means of blood and handwriting specimens; and, if anything, E. R. A. places more reliance on its ability to localize than it does in the high accuracy claimed for its general diagnosis.

Radiograph of infected teeth of our case B, after extraction of a tooth

Here again it becomes necessary for the Scientific American Abrams Investigation Committee to seek first-hand proof as the result of tests. Were we to take the testimonials of E. R. A. at their face value, we should be obliged to admit the condemnatory statements of those who have already investigated certain phases of electronic work. Obviously, it would not be fair nor scientifically correct to admit one side of the evidence without admitting the other. Time and again we have been asked by E. R. A. to accept their evidence at its face value, and time and again we have offered to publish their side of the story on the condition that each and every bit of their evidence be subjected to proper examination, and that we be permitted to publish evidence supplied by parties who have investigated and who are now quite obviously antagonistic to the progress of E. R. A. And so we arrive once more at the conclusion that the best evidence is that which this impartial committee can gather through its own efforts, and over which it has absolute scientific control so as to have its findings based on cold facts rather than mere hearsay and highly colored claims.

So in the matter of localization, we have sought a test with a competent electronic worker, an E. R. A. worker if possible, but at any rate a competent "electronist." By now it should be clear to those who have followed the progress of this investigation that while there are genunie E. R. A. workers and non-E. R. A. workers, the technique is uniformly based on the same broad principles enunciated by the late Dr. Albert Abrams of San Francisco, the founder of the Electronic Reactions of Abrams school of medicine, known as E. R. A. for the sake of brevity. Whatever may be the impelling motive, the fact remains that many of those who have taken the authorized E. R. A. course of instruction and who have started out with authorized E. R. A. equipment, have in short order gone about devising their own variation of the so-called electronic diagnosing and treating equipment. Always, of course, the claim is made that because of the desire to place electronic technique on a more scientific and stable basis, this particular doctor to whom you happen to be speaking has spent vast sums of money and vast funds of brain power to the end of evolving this particular kind of apparatus. Of course, Abrams is given full credit for the basic discoveries—the radioactive properties of blood; the human reactions in the abdomen, which are detected by percussing, feeling, or rubbing the abdomen with a glass or vulcanite rod; the different disease wave-lengths or rates, starting with the famous "57" of pickle fame; the treatment of electronic disease findings by means of similar waves or rates, working on the homeopathic theory that like cures like. Always—always, please remember in the future—Abrams is the foundation on which the electronic equipment is based. BUT—Abrams, we are assured, was crude. He lacked scientific training. True, he was a great doctor, but when he made these startling scientific discoveries he did not have the necessary scientific training to work them out to the necessary polished state of the present products which you are now beholding. These products are scientifically correct; they work with the utmost precision; they are a vast improvement over the crude Abrams apparatus, so we are told.

There are today some fifty brands of electronic equipment aside from the simon-pure Abrams apparatus. The genuine E. R. A. men using genuine E. R. A. equipment will tell you that all other brands of equipment are to be taken with a grain of salt. The genuine apparatus of Abrams has many secrets locked up in its admittedly crude cases, and therefore works where others fail. Any test which this Committee undertakes with a non-E. R. A. man using non-E. R. A. apparatus is immediately repudiated by the dyed-in-the-wool E. R. A. men. Take the other side of the picture: the non-E. R. A. men using non-E. R. A. equipment will tell you that the genuine E. R. A. workers are relatively crude and are working with hopelessly inaccurate apparatus. Therefore, any test made with a genuine E. R. A. worker using genuine E. R. A. equipment is immediately repudiated by the non-E. R. A. group. And to make the matter still more humorous—if there can be any humor in this huge movement which has enrolled upwards of four thousand doctors throughout the country—any E. R. A. worker who submits to an official test is immediately disowned on the various grounds that he is incompetent, that he is not using the very latest technique, that his equipment is of an ancient vintage famed for its inaccuracy, and so on. And so it goes.

An investigator soon begins to wonder whether it is possible to get together a genuine E. R. A. worker, equipped with a genuine, accurately calibrated E. R. A. outfit, working with a genuine subject or reagent, provided with specimens of blood or handwriting which have not been tainted somehow, and with generally favorable conditions, such as a non-antagonistic frame of mind on the part of the investigators, so as not to upset the delicate reactions.

However all that may be, the fact remains that the technique is always the same. The basic principles are the same. The reactions, on which the entire electronic structure rests, are the same. Quoting from a letter from Dr. Jean du Plessis, head of the Chicago College of Electronic Medicine and one of the leading E. R. A. workers, "You are of course aware of the fact that the type of apparatus makes mighty little difference in proving the existence of the essential phenomenon." So, here we can put down on record, once and for all, that no matter what particular brand of apparatus is employed in any of our tests now or in the future, the essential phenomenon is nevertheless under test just as much as if we were working with a genuine E. R. A. outfit.

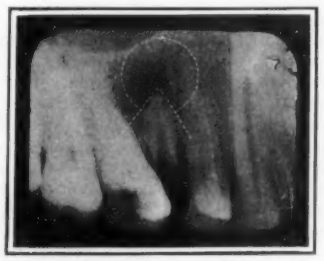
It appears that the non-E. R. A. group have been taking keen delight in the fact that so far we have received no tangible co-operation from the genuine E. R. A. camp. Indeed, the non-E. R. A. group of late have put forth the claim that the reason why no conclusive E. R. A. demonstrations were forthcoming was because the E. R. A. apparatus was defective. In fairness to E. R. A. let it be said here that every demonstration we have witnessed with the use of non-E. R. A. apparatus, no matter how elaborate that apparatus may be, has failed to prove the validity of the basic claims. All the electronic workers are pretty much in the same boat so far as their ability to prove anything is concerned—at least up till this writing.

All of which is rather off the main track of this particular report on the progress of our Abrams investigation. However, it is quite necessary to settle, at this time, this question of genuine and independent electronic workers and their apparatus.

Some time ago a well-known gentleman in Los Angeles, who has taken a keen interest in the Abrams controversy, suggested that we make a test with a doctor connected with a Pacific Coast electronic laboratory, for the purpose of testing the remarkable accuracy of electronic localization. Through this gentleman's kind offices we submitted two specimens of handwriting as directed, these specimens representing two dental cases with clearly defined abscessed teeth. The electronic worker was to identify the abscessed teeth by means of the handwriting specimens. And so we have the electronist's report of his findings, as well as the report of the dentist, Dr. Mitchell of the Bronx, who co-operated with us in the selection and preparation of the cases for the electronic examination.

The first patient was our case A. He came to the dentist's office with a badly infected tooth. Orthodox dental examination disclosed an infection around the upper right second bicuspid. It may be mentioned here that this tooth is the one immediately ahead of the upper right 6th year molar. Reference to the accompanying radiograph will clearly indicate the infected area within the circle. The light area, within the arrow-head, tooled in on the engraving for reference purposes, shows the diseased root of the tooth.

The second patient was our case B, who also reported to the dental office with a badly swollen face due to an infected tooth. Orthodox dental examination disclosed infections in the right central and upper left lateral teeth, the infection of the latter being deep-seated and necessitating considerable treatment and drainage. The circle in the radiogram of this patient shows the infected area after the extraction of the upper left lateral tooth.



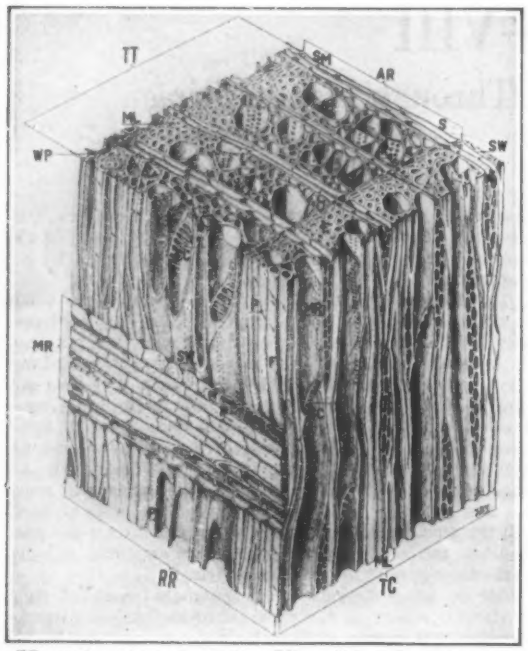
Radiograph of infected teeth of our case A

Hence in both these cases we had clearly defined abscessed conditions, which were sufficiently developed to make them identifiable beyond the shadow of a doubt by any means which lay claim to even a modest degree of accuracy. We were assured beforehand that the electronic worker in this case, as well as his electronic laboratory, scored very high in this kind of work; hence we looked forward to a clean-cut success in both these cases, if electronic localization was to be taken seriously.

In due course we received a letter from the Los Angeles gentleman, stating in part: "I am herewith enclosing memorandum of the two teeth which Dr. ——— thinks he has located as being abscessed according to the handwriting you have sent on to me. Dr. ——— made this diagnosis with a machine constructed especially for himself and he

(*Continued on page 361*)

DOES a drop of blood give off emanations by which it is possible to diagnose the donor's state of health? Can the same thing be done with a specimen of handwriting? Is it possible to carry out the most accurate kind of diagnostic work with a collection of pseudo-electrical apparatus of the crudest kind, together with a blood specimen and a human "detector" or "reagent"? Is it true that numerous cases given up as hopeless by orthodox physicians, have been cured with a machine known as the oscilloclast, which is claimed to give off some form of energy that cannot be detected by normal physical or electrical means? These are some phases of the Electronic Reactions of Abrams technique which the SCIENTIFIC AMERICAN *set out to investigate. Reports on the progress of this investigation have appeared in every issue of this journal, beginning with the October, 1923, issue. The reader is referred to the back numbers in order that the present report can be clearly understood.*—THE EDITOR.



TT: section across the grain. *RR:* radial surface ("quarter-sawed" or "edge-grain"). *TG:* surface tangential or parallel to the annual rings ("flat-grain"). *MR:* medullary rays. *V:* vessels. *F:* wood fibers. *S, SM:* "springwood" and "summerwood" portions of the ring. *P:* pits. *SC:* gratings at longitudinal junctions of vessels

Fig. 1. Highly magnified view of a block of hardwood, showing its cellular structure, from a drawing by the author based upon actual micro-sections

Does Paint Preserve Wood?

A Conflict Between Theory and Practice, and How It Is Explained Away

By H. D. Tiemann

Dry Kiln Expert, U. S. Forest Products Laboratory, Madison, Wis.

DOES painting actually preserve wood? And if so, how? The question is not so simple as it seems. Ask the timber pathologist, and the answer is that there is nothing in ordinary paint which is poisonous to fungi and therefore it does not prevent decay by any antiseptic action. So far as known, decay occurs and can only occur through the action of fungi. He will say, furthermore, that paint may even induce rapid decay by keeping the wood damp on the inside, retarding its rapid drying when placed in a situation where it frequently is subject to wetting —in other words, introducing a factor of lag in the wet-dry cycle.

The wood technologist, moreover, will tell you that paint does not prevent the absorption of moisture from the air. While undoubtedly a retardant, it does not act as a moisture-proof seal; and nothing but hermetically sealing up the wood will prevent its ultimately absorbing moisture if exposed to a damp condition long enough. Some forms of varnish are better in this respect, shellac is good, and paraffin is better still. Three coats of spar varnish may postpone the final action for a month or two, but linseed oil paint, even in heavy coatings, will only delay the evil a few weeks. Consequently the "working" of wood — its shrinkage and swelling with exposure to dry and to damp air for considerable lengths of time — cannot be prevented by painting or varnishing. This phenomenon is only too familiar to every householder as well as woodworker through the shrinkage and swelling of floors, doors, picture frames, and furniture. In heated rooms in winter the moisture content will drop to four or five per cent of the dry weight, and in summer, with outdoor conditions in the house, it will rise to 12 or 14 per cent or may even reach 18 or 20, with attendant sticking of drawers and rubbing of doors.

Now suppose you go to the builder or the practical man in general and ask him about this matter of paint. His verdict, based on years of experience, will of course be that painting is highly beneficial in protecting the wood.

Are the technical men wrong? Or can we somehow reconcile these apparently conflicting ideas?

The answer lies in the behavior of wood to the influence of moisture, a manner of behavior which is not generally understood. All the statements made are true, and it is interesting to follow out the way in which paint actually does prevent or retard the destruction of wood. We need not appreciate paint less for knowing wood better.

Some of the phenomena which take place when wood dries will need explanation. Perhaps the most important of these is the peculiar propensity of wood to become "set" or fixed in the position and dimensions in which it is held while it dries. While wet, and particularly when warm, it is somewhat plastic and may be distorted to a certain extent by applied forces. If the forces are applied continuously during the drying, the wood will harden and retain the distortion even after the forces are removed.

This statement applies not only to the piece as a whole, but also and more especially to the internal structure. Suppose a piece of wood which has been thoroughly moistened is prevented by framing or bracing from shrinking until it is dry; it will become "set" in its expanded condition, and will remain enlarged after the bracing has been removed. The internal stresses set up at the start seem to have disappeared entirely. But they have only become latent, as it were; and if the wood is remoistened they will again reappear in full force and effect. For example, if a piece of bentwood be remoistened it will tend to straighten out, particularly if heated. The hardening process is thus quite a different thing from the hardening of cement, where the stresses do not thus become latent, and it should not be thought of in the same way.

The actual internal mechanism of wood behavior under moisture changes is unknown; but in order to picture what will occur in wood under given circumstances the following analogy may help. Imagine a honeycomb in which the cell walls are composed of a substance which is plastic and somewhat elastic, like rubber, when wet, but loses these properties when dry, hardening in whatever shape it is held while drying. Furthermore, suppose that the substance itself swells and shrinks with moisture changes. Suppose we take a wet block of this honeycomb and compress it by an external applied force. The result will be that the cells will become distorted; instead of being hexagonal they will become more elliptical in outline. Now let the substance be dried while being held in this distorted condition. The walls will at first stiffen up and lose their elasticity so that there is no longer any tendency for the cells to resume their hexagonal form, the stresses thus disappearing or becoming latent. This is an explanation, or a fairly good picture at least, of the "setting" of wood in a distorted shape or size when it dries.

At this stage a further important effect of drying will occur; the same process will be noted when we come to the actual phenomena of wood. The wall-substance itself, according to our hypothesis, will begin to shrink, and the result will be that the block as a whole will finally reach a *smaller* size than it would have done had no compression been applied to start with. (A similar result of the opposite kind may be produced by stretching the block originally.

Now, to come closer to the main point, let us suppose that we start with a dry block of this honeycomb and clamp it in such a way that it is impossible for it to swell (just like honeycomb in its square wooden frame), but that we exert no external compressive force upon it other than the resistance to its own swelling. Now let it be moistened, and what will happen? The cell walls will swell, but as the block as a whole cannot expand, the walls of the cells will crumple, distorting the form of the cavities. If now the substance be dried it will harden in the new crumpled shape, the stresses becoming latent exactly as in the other case. The cell wall substance will then shrink as before and the whole block will pull away from the box, and it will now occupy a smaller space than it did originally before it was moistened. Upon remoistening in a free condition the crumpled walls will resume their elasticity and tend to return to their original shapes. Fig. 1, which is a drawing of a grain of hardwood sawdust highly magnified, shows that our honeycomb analogy for wood structure is not so very far from actuality.

Coming now to the actual drying of a piece of wood, the sequence is this:

The outer surface, drying first, tends to shrink but is prevented from doing so by the moist interior. Stress is set up, the outside in tension, the inside in compression. The outside then becomes set ("casehardened") in its expanded condition, as explained in the analogy. As soon as the free water has all evaporated from the cavities of the interior cells ("fiber saturation point" passed), the inside of the block tends to shrink but is in turn hindered from doing so by the expanded set exterior. The stresses are therefore reversed, the inside now being in tension. As drying proceeds still further the inside becomes "set" in an expanded condition which, owing to a slight yielding of the exterior, will be of a less degree than the set of the latter, or else the tension will become so great that the fibers will actually pull apart, causing what is commonly designated as "honeycombing" or "hollow horning."

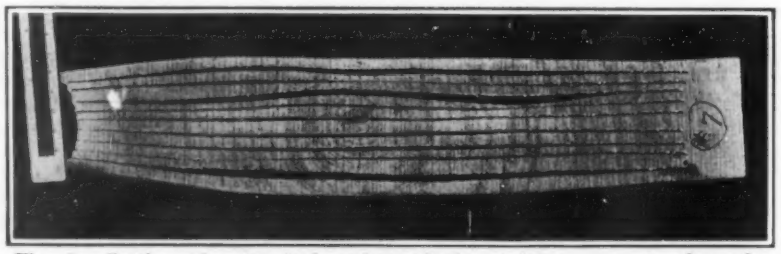
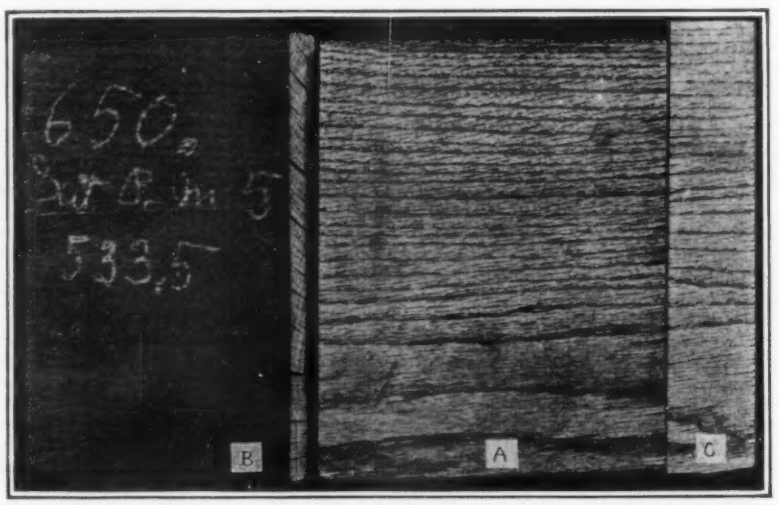


Fig. 2. Section of a two-inch walnut plank cut into prongs to show the stresses which occur internally during drying

These stresses are easily proved by cutting a cross-section from a dried block and slicing it into prongs like a fork. The unbalanced stresses cause the prongs to curve, the tension side being concave and the compression convex.

By an indirect method the set condition is also easy to show. If the section be sliced into prongs when only half dry and then allowed to dry slowly in the air, the outer prongs will shrink much less than the



C: piece in original air-dry condition. *A* and *B:* steamed and redried; *A:* prevented from swelling by a clamp; *B* free. Note the end checks on *B* due to the restriction on swelling imposed by the rest of the board

Fig. 3. Oak board showing the result of prevented swelling when moistened

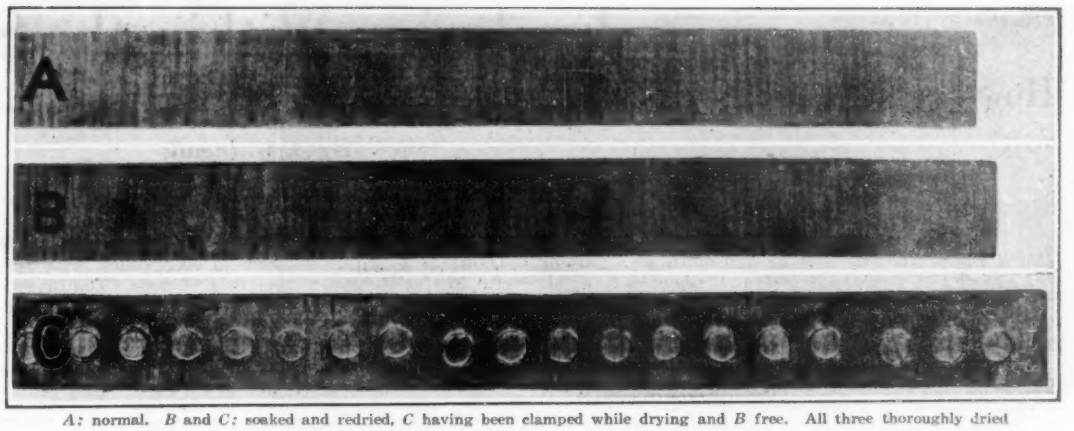
inner ones, owing to their already set condition. This is clearly shown in Fig. 2, which is a section of a walnut plank treated in the manner just described. The internal stress which would have existed had drying been completed before the slices were made is approximately measured by the force which would be required to bring all the prongs to the same length. This is evidently considerable. Can you wonder at a piece of lumber for cracking open or warping under such stresses? Yet this condition is not the exception, but the general rule. In fact, it is practically impossible to dry a piece of wood wihout such stresses occurring to a greater or less degree. If there is doubt about this in the mind of anyone, let him make the test himself. It is very easy. The section should be cut while the board is still damp inside, as explained above.

We are now able to predict what is likely to happen to a piece of wood exposed to the weather. If a dry piece of wood is held or clamped in such a way that it cannot swell and it is then moistened, a strong compression stress will be set up by the wood itself in itself, which will act in the same manner as an applied external force. If the wood is redried under this restriction it will become "set in compression" to such an extent that when it finally reaches its original state of dryness it will be *smaller than it was before.* By repeating this process a piece of wood may be made smaller and smaller. By the method of repeated wetting under restriction and then redrying, a strip of air-dry basswood 9-15/16 inches long tangentially to the rings was compressed to a length of 7-7/16 inches.

Fig. 3 shows a one-inch oak board from which the smaller end section was first cut off and the larger piece cut in two. One-half of the larger piece (marked *A*) was then clamped in an iron frame so that it could not expand tangentially, was steamed about a day, and was subsequently allowed to dry again. It soon became loose from the clamps and finally shrank to the size shown in the photograph. The other half, *B*, received precisely the same treatment as *A* except that it was not held in the clamp while being steamed and was free to swell as much as it pleased. Notice, also, that the ends of the piece which was not clamped are very much checked. This is not an accident, but is due to the same cause. Since the wood takes on moisture much more rapidly at the ends than in the middle, the ends tend to swell; they are prevented from so doing, however, by the middle portion of the block. The ends are therefore thrown into strong compressive stress, just as the clamped block was, and when the block is dried they will, in the characteristic manner, shrink more than the rest of the block, thus opening up in wide end-checks.

This is not merely an interesting laboratory experiment of purely "scientific interest": not by any means. It is one of the most fundamental facts concerning the behavior of wood and applies all the way from the lumberman's shanty to the finest piece of furniture in the lumber king's palace; but it is not commonly understood.

The reverse of this action may also be brought about, as in the casehardening of the outer surface of wood, illustrated in Fig. 2. In Fig. 4 are shown three strips of basswood, all cut adjacently from an air-dry flat-grain board. The length of the strip is tangential to the rings. *A*, which is ten inches long, was retained in its air-dry state. *B* and *C* were soaked in hot water, *C* being then clamped between two strips of perforated iron. All three were then thoroughly dried at 200 degrees Fahrenheit. The piece *C*, held in the clamp during drying, could not shrink appreciably and became "set" in this expanded condition, in which it now remains indefinitely after removal of the clamp and will so remain until it is soaked again.



A: normal. *B* and *C:* soaked and redried, *C* having been clamped while drying and *B* free. All three thoroughly dried

Fig. 4. Experiment showing how wood may become set in expanding condition

But what has all this to do with paint? Let us see.

In Fig. 5 is shown the cross section of a well dried piece of red oak which showed no checks. The central area was then wet several times with hot water, care being taken not to wet the surrounding portion. Upon redrying, the cracks appeared as seen in the photograph. Now these cracks were not produced by the wetting and drying alone, but *by the compression stress caused by the restriction to swelling, the subsequent setting of the substance under compression, and further shrinkage as it redried.* Repeated wetting and drying causes an accentuation of this condition. It is this identical process which causes exposed surfaces of wood everywhere to crack open and become weathered. One frequently observes its results in hardwood window and door sills, flooring and steps, which are subjected to repeated wetting and drying. As dirt enters the cracks the compression is thereby increased each time the surface swells; when it dries, the openings become wider and the cracks strike in deeper and deeper. It will be observed that at first it is only a *surface effect* and is due to the prevention of the swelling of the surface by the deeper portion of the wood which has not yet become wet. It is the abrupt changes in moisture content between the surface and the inner layers of the wood, or between any adjacent portions, which are responsible for the conditions of surface checking and subsequent deterioration.

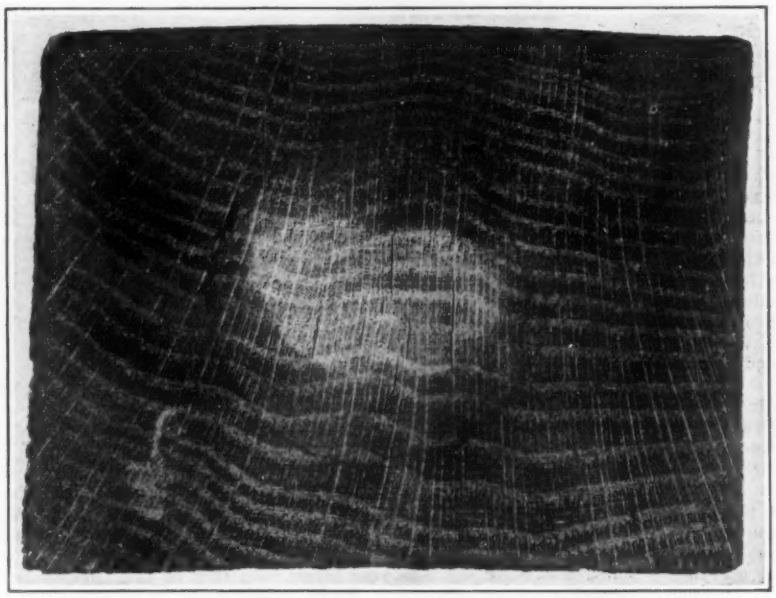


Fig. 5. Section of oak, showing compression checks produced by wetting and redrying a small portion

Paint is not proof against gradual absorption of moisture and therefore will not prevent swelling or shrinkage from taking place if given sufficient time; what it does do is to *retard the rate of absorption or loss of moisture through the surface,* thus giving time for a partial equalization of the moisture and reduction of the moisture gradient within the piece. Paint does not make wood poisonous to wood-destroying fungi, but by preventing the surface cracks it makes it harder for the fungi to get a foothold and so helps to preserve the wood.

The equalization of the moisture distribution throughout the piece brought about by the coating of paint, when applied to all surfaces, also prevents excessive warping of the piece as a whole.

Fig. 6 shows an oak board which has become considerably cracked in the central portion. This board, a flushtank cover, was subject to repeated wettings and dryings. The surrounding portion which is not cracked was protected by a coating of paint and oil, whereas the coating had entirely worn off the central portion. The explanation has been suggested, and the result speaks for itself.

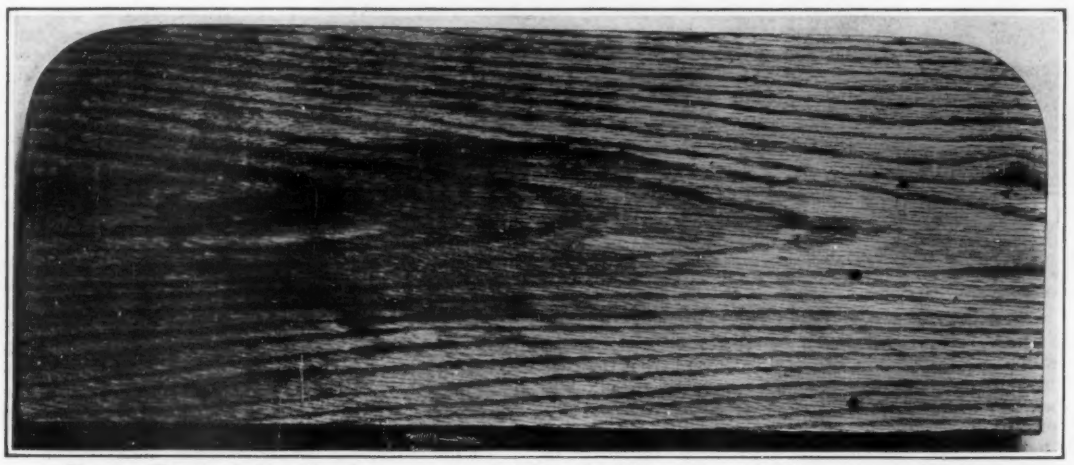


Fig. 6. The checked portion here was unpainted, and subjected to repeated wetting and drying

A New Trade, the Straightener?

A CONTEMPORARY suggests that there is one line of repair work that is practically untouched so far as specialization is concerned, yet is peculiarly adapted to segregation and placing in a one- or two-man shop. There is a never-ending volume of straightening to be done, and it can be made to pay much better than ordinary repairs. The "straightening shop" is badly needed in the automobile repair business and the machinist of ability in that line will be received with open arms. The wear and tear of every-day running, the uncorrected loosenesses, clean breaks, little accidents of driving, and all the happenings included under the name of "wrecks" serve to feed the job list of the straightening shop. An expenditure for equipment that would put in only the gas tank and pump of a garage or would but poorly equip another specialty shop, will fit up the place in first-class shape for straightening work of every conceivable description.

Exploring Within the Steel

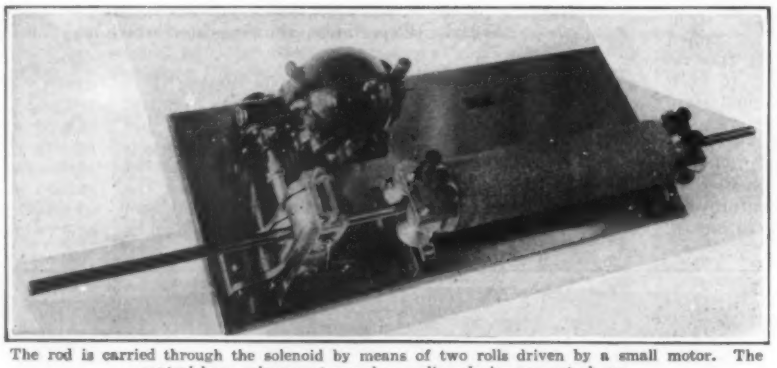
How Magnetic Analysis Indicates the Presence of Flaws in Rails and Beams and Hoisting Cables

By A. G. Ingalls

LET us imagine that there is a hidden transverse fissure in the center of a steel rail, but you do not know it is there. That rail will later be laid down as a part of a railway track and some cold night, when the steel is chilled to increased brittleness, there will be a complete fracture followed, perhaps, by a disastrous wreck.

That thing has happened many times because there has until recently been no sure way to discover the presence of the hidden defects in the interior of a piece of steel. The same is true of all kinds of flaws, not only transverse fissures but slag inclusions and hard or soft spots. But a method for finding such imperfections has been discovered and recently put to work, and that method happily permits the entire output of a steel mill or factory to be investigated just as rapidly as it is produced.

Magnetic analysis is, in general, just what the name suggests. It takes advantage of the various magnetic properties of steel and iron, and it permits of the making of many more deductions regarding the inside of a given piece of magnetizable metal than would at first glance seem apparent. So successfully have these deductions tallied up with the facts that the new method of testing steel has been put on a working commercial basis.



The rod is carried through the solenoid by means of two rolls driven by a small motor. The control box, galvanometer and recording device are not shown

A laboratory form of rod defectoscope

To give a brief peep into the nature of magnetic analysis before turning to the considerations which naturally lead up to the exposition of its methods in detail, Dr. C. W. Burrows, the pioneer in the field of magnetic analysis research, and inventor of the equipment that is being used for the analysis, has said, "There is one, and only one, set of mechanical characteristics corresponding to a given set of magnetic characteristics; and conversely there is one, and only one, set of magnetic characteristics corresponding to a given set of mechanical characteristics."

Add to this statement the fact that magnetic analysis makes use of all the several magnetic qualities of steel and iron, particularly of induction, coercive force, residual induction, hysteresis energy and the various permeabilities, as well as certain combinations of these qualities; and that it employs two types or phases of magnetic apparatus known respectively as the defectoscope and the magnetoscope, and you have a rough general statement of the question that nearly everyone asks when first confronted with something new. That is, "How does it work; and why?"

Before taking up in detail how it works and why, two significant considerations must be gone into. If we are to get a background for an understanding of magnetic analysis as it has been commercialized today, we must know a little about who began it and who has been behind its development. Such knowledge gives a sense of proportion to those who have not found it possible to keep in intimate contact with the salient developments of the steel industry. We must also try to grasp the great importance of the testing of the materials of construction, and briefly review the tests that have been used by industry in an effort to know the nature of the steel and iron used.

The progress of magnetic testing of steel has been carried on by the aid and encouragement of great railways, and great manufacturing industries. Much of the fundamental work was accomplished in the United States Bureau of Standards, at Washington. Numerous university professors of physics and engineering have also collaborated in its investigation.

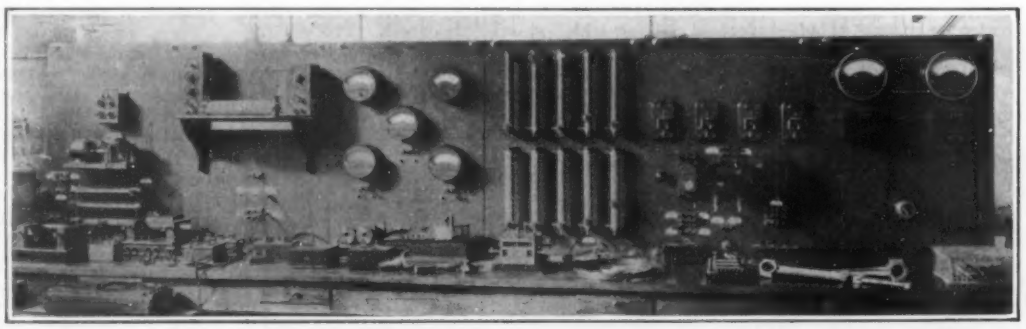
In 1906, Dr. C. W. Burrows, who was in charge of the Magnetic Section of the Bureau of Standards, began an investigation of the general problem of the relation between the magnetic and the mechanical properties of steel.

During that year Dr. Burrows was carrying on an important magnetic research in cooperation with several foreign magnetic specialists of note. The investigation required two short steel bars of identical magnetic properties. This seemed to be a simple requirement but it soon became evident that two bars one-half inch in diameter and ten inches long, having identical magnetic properties do not exist. They cannot be made. Many thousands of dollars was spent on a fruitless search, while specialists and steel experts were unable to give any help. Then special furnaces for the preparation of the desired pieces of steel were prepared, while the rolling and annealing were given a care that would make a royal babe seem neglected. And still the resulting bars, prepared as carefully as modern science could prepare them, showed magnetic differences.

This extreme sensitivity of the magnetic test of bars having identical properties when measured by other methods of testing, whether chemical or physical, seemed highly worthy of further investigation, and the knowledge gained from the subsequent research has turned out to be of vastly greater value than would have been a successful conclusion of the original piece of research.

Four years later the Pennsylvania Railroad began an independent investigation of magnetic analysis, which was combined, one year later, with that of the Bureau of Standards. This joint investigation continued at Washington for six years, during which period the value of the new method of analysis as an aid to technical research was clearly demonstrated.

In 1918 the American Society for Testing Materials, of Philadelphia, appointed a committee on magnetic analysis, consisting of research engineers from the tool, ball-bearing and rifle industries, together with a representative of the New York Central Railroad, and several professors of physics and engineering, all cooperating under the Chairmanship of Dr. C. W. Burrows. In 1919, representatives of the National Research Council, and of the War Department as well as of leading universities and several additional industries which had taken up magnetic analysis during the year, were added to the special magnetic analysis committee of the American Society for Testing Materials.



The instrument board supports a collection of ammeters and voltmeters, an A. C. indicator and a heavily damped D'Arsonval galvanometer. Toward the right are four relays for operating the signals used with the defectoscope and A. C. Analyzer. Directly above them are two colored lights that flash momentarily when spots that are harder or softer than the average of the steel pass the solenoid. In the foreground is a special type of magnetic comparator used for testing handsaw blanks for correctness of heat treatment. By testing these blanks before polishing instead of afterwards as had been necessary before the use of magnetic analysis, a considerable saving to the manufacturer was effected

A corner of the Burrows magnetic laboratory

This Philadelphia society is very largely responsible for our present knowledge of the materials of engineering and for the standardization of specifications and method of testing. Formed in 1902, it has a very large membership among the engineering and allied professions, and it has kept in existence forty standing committees with a total membership of about 1400 for the purpose of studying the properties of materials of engineering and developing standard specifications, methods of testing, definitions and recommended practice. Its activities are intimately woven into our whole industrial fabric. Naturally its work is known to a lesser degree outside of the engineering profession than within it, because it is of such a nature that it does not often penetrate through the fundamental layer of the constructional world formed by that profession. But its work nevertheless stands underneath the whole structure.

The great and fundamental importance of testing the materials of construction cannot be overestimated. Not only money and things, but life, depends upon it. Take the case of railway rails. There you have a comparatively concentrated mass of iron and steel, the locomotive, weighing up to nearly a million pounds thundering over a pair of steel ribbons that must be free from flaws if they are to withstand the stresses they are subjected to by such great weights in motion.

Our railroads buy two million tons of steel rails every year. The great automotive industry uses another three and one-half million tons. Another five million tons go into buildings, bridges and other structural work. All of these things have direct connection with the safety of human lives. This fact furnishes one of the chief reasons why steel must be tested before it is used.

Users of steel usually refuse to buy an ounce of it unless they know its composition accurately. Yet none of that which they buy and use has been tested. Here is a paradox!

When we state that a given lot of steel has been tested and the analysis returned we mean simply that samples of it were tested. One hundred tons of steel is made, poured into ingot molds, rolled out and a few pieces chosen at random for tests. Even at best it is a case of testing one piece out of a dozen, or a hundred, and gambling on the hope that the remainder are like this piece which has been destroyed in the process of testing. This is essentially a hit or miss method, but until the development of magnetic analysis it was the best method known.

Not only is the method of basing the quality of a batch or lot of steel on tests and analysis of mere samples fraught with the ever-present danger that luck may play strange tricks with the choice of samples, but it involves the destruction of these samples. In order to test the transverse strength of a structural steel shape you must bend it past the elastic limit and destroy its usefulness. In order to make a chemical analysis of a sample you must ruin it. If you wish to examine it under the microscope you must cut it up into very thin sections. The piece you test is never the same piece you are to use. It is one of a lot, and your faith must make up for the uncertainty involved thereby.

In the early days the judgment of the workman was the chief criterion of steel quality. He looked at

the grain of a freshly broken piece, judging it by a "blow of the eye." Then there was the cold bend test in which he bent a piece flat on itself and examined the stretched fibers, or he broke a piece of the steel and "read his carbon by fracture."

Later tests largely eliminated the human factor. The tensile test is made in a powerful machine which tears the test piece in two, giving a record of its strength. This is necessarily a destructive test. The compression test, where the test piece is crushed, is likewise a destructive test. The bend test is of a similar nature.

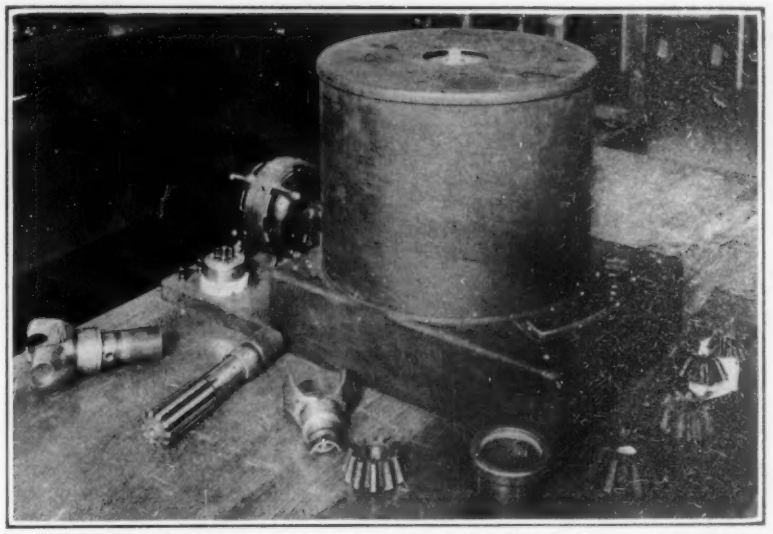
One very important test is that for determining the hardness of steel. The scleroscope, which is sometimes used for this purpose, makes use of a little steel hammer having a slightly spherical striking point, two hundredths of an inch in diameter. This is dropped a distance of ten inches on the test piece, making an indentation and rebounding to a measurable height. The impact corresponds to a pressure of several hundred thousand pounds per square inch, and the hardness of the sample is measured by the amount of rebound. A second test of hardness is called the Rockwell test while a third method which is very widely used is the Brinell test. Here a hardened steel ball is forced into the metal, making a tiny concavity. The maximum pressure applied, divided by the area of the concavity, gives an arbitrary "Brinell number," or hardness number. This test is non-destructive, but it tells nothing further than the surface hardness of the steel. Hidden flaws are not found by it.

Chemical analysis is one of the most important methods used for learning the facts about a batch of steel. A well-equipped chemical laboratory forms a part of all modern steel plants. But it likewise applies only to samples; and it also ranks as a destructive test. However, chemical analysis will always remain an invaluable aid to the steel maker.

Metallography is a method of examining sections of steel or other metal under the microscope. Sections about one-half inch square are ground down to a fine polish and examined microscopically; then they are deeply etched in order to show the crystalline structure. Says Professor Bradley Stoughten of Lehigh University, "In the United States, practically every large steel works is well equipped for the microscopic analysis of its product. Although only a little more than 25 years have elapsed since the first art received attention, it has advanced so far as to have become by now another and very serviceable tool in the hands of the expert. But," continues Prof. Stoughten, "reputations have more than once suffered severely because of erroneous deductions made from miscroscopic evidence."

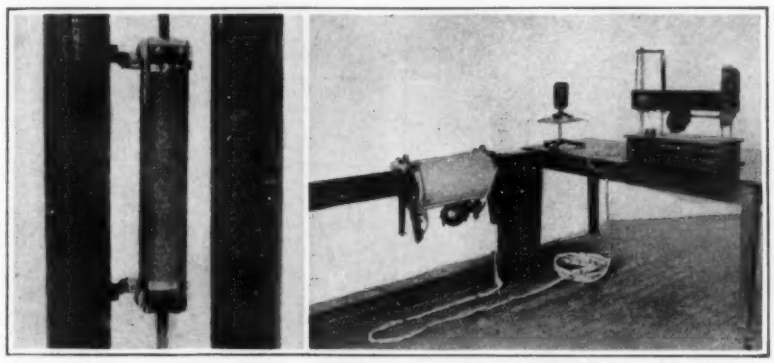
The examination for homogeneity of iron and steel by means of the X-rays is becoming common. Yet it is so slow that it can be applied only to thin work or to suspected places. At the Watertown Arsenal a very expensive 300,000-volt X-ray apparatus is able to make clear and distinct photographs through a thickness of one inch of steel in one minute. But a two-inch thickness requires five minutes; while three inches, the present limit, consumes thirty minutes. Greater thickness than this may be "seen through" by magnetic analysis almost instantaneously, permitting long, heavy products to be moved along at a lively rate of speed while they are examined. The fact that the relatively slow X-ray study of steel has exposed many previously unsuspected defects, such as forging and shrinkage cracks, shrinkage cavities or porous spots and burnt metal favors the use of the far faster magnetic analysis for the same purpose.

It must be made clear that magnetic analysis is not intended as a substitute for all of the forging methods of testing steel. Rather, it complements them. In addition to telling us by newer methods things we can already find out by the ones that have been in use, it tells us things we have never been able to know. Because its intangible magnetic fingers search within and throughout a piece of solid metal it is able to locate physical defects that cannot be known in any other practical manner. Better still, these all-permeating magnetic feelers leave no harmful trace of themselves. When they have passed and done their work the steel remains as sound as before.



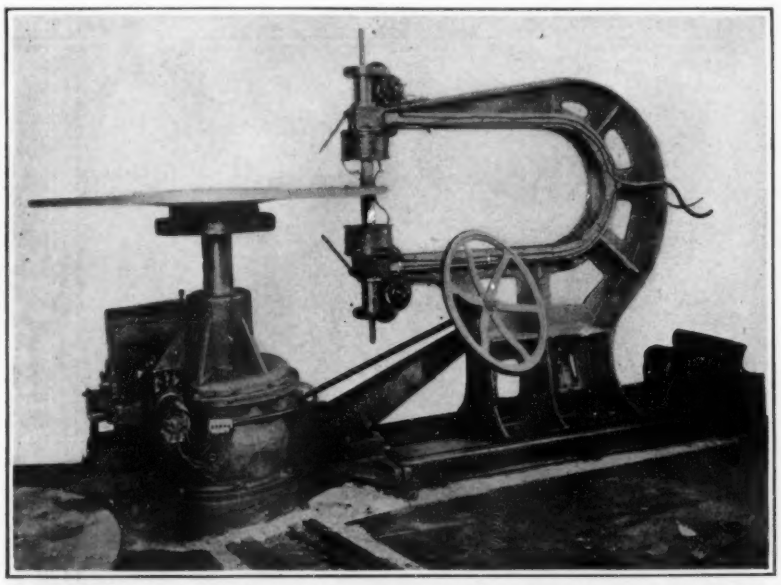
This equipment is designed to test all circular parts, such as pinions, races for ball and roller bearings, etc. It determines defects in machine parts, depth of case after carburizing, and physical structure after heat treating. The magnetic field is revolved either mechanically or by means of a polyphase current, while the average nature of the piece is determined quantitatively

Analyzer for testing round specimens



Left: This form of defectoscope may be kept permanently mounted in shaftways for periodical tests of stranded cables. The control and recording apparatus are located at a distance. *Right:* Instead of moving the rails through the solenoid as is done in commercial installation, the rail here remains stationary while the solenoid is caused to traverse its length by means of a small motor

Solenoid of cable defectoscope in place in elevator shaft, and the laboratory form of defectoscope



Bucket wheels for steam turbines must be of irreproachable quality and homogeneity. In this installation a ten-foot disk is being analysed by the defectoscope in a search for blowholes and weakening inclusions. The disk is slowly revolved while the instrument is steadily moved outward from the center, thus covering the whole area in the form of a spiral

Magnetic testing apparatus for steam turbine bucket wheels

Magnetic analysis permits the large output of the steel mill or of the factory to be passed in rapid review without the aid of technical experts and without slowing up the process. The examination is sandwiched in with the regular machine-to-machine progress through a factory in such a manner that the steel has merely to be routed through the magnetic equipment without stopping. If flaws exist in the rails or rods or in any of the long shapes, a record is left, either by an automatic device which paints the piece opposite the point of defect or by a line which is automatically traced on a slowly moving photographic film. Sometimes a colored light is flashed or a bell is rung to indicate that a defect has been located.

The magnetic properties of a piece of steel are determined by its past history. Every detail of its chemical constitution, its course of manufacture, its heat treatment, and the stresses to which it has been subjected have united to determine its magnetic nature. For steel of a given history there is only one set of magnetic characteristics. Taking full advantage of this fact, there are two phases of the magnetic analysis — those employing the instruments known respectively as the defectoscope and the magnetoscope.

The defectoscope analyzes long specimens such as rails, pipe, beams, wire, shafting, rods and cables for flaws such as concealed fissures, blowholes, segregations, local hard spots and inhomogeneities. It determines whether nonuniformities exist, but does not indicate whether the specimen as a whole is hard or soft. It employs direct current. The application of this instrument has been developed quite fully.

The other instrument which is employed in magnetic analysis and which is called the magnetoscope, analyzes irregular shapes and small parts, as forgings, castings, crankshafts, hooks, and various parts for automobiles and general machinery. Unlike the defectoscope, it is essentially a comparator, in that it requires a standard piece against which it checks the piece under test. It compares its general physical properties such as hardness, grain size, and chemical composition with those of the standard piece. The magnetoscope uses alternating current, unlike the defectoscope which uses direct, and the phenomena employed in making the analysis may be either hysteresis energy or magnetic hysteresis.

Returning to the defectoscope, this instrument consists of a magnetizing solenoid and a system of two exploring coils having the same number of turns. These coils are "bucked." That is, the turns run in opposite directions. The solenoid is energized by direct current and the piece to be tested is passed through its interior magnetic field as well as through the two exploring coils which are separated from each other some inches. Any inhomogeneities in the moving steel will cause magnetic leakage as they pass. That is, the density of the lines of magnetic force set up in the metal will be altered. The changing magnetic flux reacts on the two exploring coils, generating a current in them which is stronger in one than in the other and making itself evident on a sensitive galvanometer.

When using the defectoscope there is in general no indication of the physical condition of the piece as to hardness, grain, size and analysis so long as these properties do not vary too sharply from point to point along the piece under test. So long as it is uniform no indication is given — the spot of light thrown by the galvanometer mirror remains fixed, or, if a photo-

(Continued on page 366)

The plate-glass show-window in the rear of the motorized grocery

The Grocery on Wheels

A Self-Service, Motorized Store that Effects Great Economies for Dealer and Customer

IT'S A big job that the ladies have to do every day. There is being spent today and every day in the United States $49,000,000 for food stuffs, by your wife and mine and the 35,000,000 other women who provide home meals for the tired business men—meaning you and me. You could run a mighty big war on that money. For each one of the 105 million of us these shoppers spend 45 cents today and every day. If she does her shopping by phone milady must add 5 per cent to every dollar of your money she spends. Then when the store delivers the order that adds another 10 to 15 per cent to the price—for the dealer must charge for this service or lose money on your business.

On the other hand, if the housewife goes to the non-delivery or chain store she saves the phone and delivery items, but spends an hour or more, depending on the distance which she must go, to get the groceries and meats. Even though her time has never been valued in dollars and cents—it is, nevertheless, an expense and often an inconvenience to her to spend an hour a day "at the store."

Let us look at the marketing situation from another standpoint. It has been carefully estimated that fifteen cents out of every dollar of yours spent for foodstuffs must go towards running expenses of the store—in other words into overhead. This is not for wages to the producer, a wholesaler's profit, nor transportation—but just for rent, heat, light, clerk hire, hand bills, advertising and other necessary expenses. These items, which you pay for when you buy groceries or meats at the store, consume one-seventh or a little more of your monthly food bill. These are facts, taken from proven statistics; they should be of vital interest to every man and woman.

In a typical neighborhood there are five grocery stores—three of them are chain stores. Each one of these stores draws trade from a radius of three to five blocks. The average chain stores sales in large cities are $475 per week and the average net profit is between 2 and 3 per cent—and that 2 per cent plus, is hard to get; it requires scientific management to do it. More than this, few stores turn their stock more than thirteen times per year, and they have to turn it 8½ times per year to keep out of the bankruptcy courts. You will wonder that any of them can make money when we tell you that there are 457,000 grocers and butchers for the 24,000,000 families in the country—or one tradesman for every 54 families.

Is it anything to be surprised over then, that only five grocers out of every hundred succeed in business? Fifteen out of every hundred stagger along the financial edge, barely making a living, and eighty out of every hundred last only seven years or less.

Yet, fighting against all those odds, and with all this apparent inefficiency and expensive distribution we do have groceries and good groceries too, and we also have many good business men who have studied the conditions of the sale and distribution of foodstuffs with the worthy object of making the business less hazardous for the proprietors, and increasing the convenience and lowering the cost to the customers.

Taking the store to the customers is not particularly a new idea in itself, but the store on wheels, as conceived by L. B. Watson and worked out with the assistance of M. L. Pulcher, is a long step towards solving many of these questions. In the first place the "Mototeria" is a serve-self store on wheels capable of serving 400 families per day, with a complete stock of groceries, breads and cakes, fruits, green and staple vegetables, meats and drug sundries. It has but one clerk who is also cashier as well as driver. His store is 22 feet long by 7½ feet wide, yet so conveniently are the commodities arranged, each with its own price tag, and so easy to operate is the overhead-basket carrier device that ten or twelve customers can wait on themselves at one time. If the housewife has babies and no help it is quite impossible for her to go to the store down the street, but here is a well stocked, low-priced "chain store" right at her door where she can get her "items" and be out of the house but a few minutes.

That is well enough you say, but these women have to pay extra for this service, don't they? Well that is just what Mr. Watson determined to find out. The result was much thinking and a study and planning and a thorough analysis of the field which it was intended to cover. The first unit was built and stocked complete, including everything that a chain store would carry, but having several features borrowed from the old neighborhood shop thrown in by way of good measure. The first unit was put to work in Detroit last August. To the gratification of Mr. Watson and Mr. Pulcher the shoppers took it up immediately. While they had appreciated the chain store with its lower prices, yet they had had to carry the goods some distance which was usually a bother. Here was a store which was lighted and heated, neat, clean and sanitary—but best of all with everything needed for breakfast, lunch or dinner and with good savings on each item. Naturally the women liked it—and the operators were both surprised and pleased over it.

Where the average chain store receipts were under $500 per week the Mototeria started doing a $1,000 business per week before it had been long on the route. Further, by a reduction in clerk hire, savings in rent, light, heat, window displays, and other items, the profit increased from 3 per cent to 12 per cent even when the retail prices were kept equal to the chain-store prices. Instead of drawing an indifferent trade from a radius of three to five blocks this store visited the families in 35 to 40 blocks every day.

Further, it was found that the turnover possible by increasing the number of customers was almost unheard of in the grocery or meat trade. The turnover of the usual chain store is thirteen times per year, while a ten-cent store turnover averages 24 times. The Mototeria turns its stock 100 times yearly. Daily replenishment was found to lighten the load and permitted carrying of a greater variety as well as assuring fresh stocks at all times.

The Mototeria carries assorted meats, but mostly cold meats for immediate use, because of lack of cutting facilities. Its meat-order system, however, is a great convenience and saving to both operator and customer. Meats are ordered one day for the next. These are cut exactly as ordered, both as to the particular cut and also as to the weight, in a central, sanitary refrigerating plant and wrapped and labeled for delivery to the customer. It has been estimated that an operator with eighty such stores could save $60,000 per year on efficient meat cutting alone, and another $60,000 for truck hire for trucks now used in supplying the regular stores.

A plate glass "show window" in the rear of the Mototeria provides display of green groceries and fruits. Potatoes and other bulk vegetables are sacked in varying quantities in bins all ready for the customers. In winter the Mototeria is heated by a novel system utilizing the hot water from the engine. This eliminates the "gas smell" noticeable with the use of exhaust heaters. The store is ventilated by a device for that purpose in the roof.

It is also planned to have a laundry pick-up with one or two day service in connection with the Mototeria. Large compartments are provided in the body for this purpose. A banking system which is done by a stamp and card system has also been worked out by the designers of the new store which has many interesting phases. The taking of coal orders with one day service is still another plan which may have many economic sides. Indeed it is well within the probabilities that this system of household service with its many attractive features may revolutionize our whole scheme of food and household necessity distribution, and it is within reason that the bulk of the purchases for the household will be done in future right at the door.

General appearance of the grocery store on wheels

The man in charge is really a chauffeur-cashier, rather than a clerk

Washington Memorial Bridge at Wilmington

THE handsome monumental bridge across the historical Brandywine Creek in the City of Delaware, herewith illustrated, constitutes a memorial to the Delaware soldiers and sailors of the Nation's wars, and especially of the World War. Situated in the North central part of the city, this bridge, enhancing the beauty of the natural scenery in a locality that was the theater of stirring events during the war of the Revolution, and which is inseparably associated with the name of General Washington, not only commemorates the patriotism of the citizens of the State of Delaware, but also serves to carry the important vehicular traffic of the Washington Boulevard.

The new bridge is 720 feet long and 72 feet wide and consists of five reinforced concrete arch spans; two 70 feet in length, one 250 feet, and two 85 feet in length; together with the necessary approaches. Each span consists of three arch ribs, 11 feet, 16 feet and 11 feet wide respectively. The deck of the bridge consists of a 40-foot roadway paved with sheet asphalt; two sidewalks 14 feet, 9½ inches in width; and two balustrades or railings 1 foot, 2½ inches in width.

The piers of the bridge are on a 30-degree skew, and the large 250-foot span of 40-foot rise is probably the longest, low-rise, skew arch span in the United States, if not in the world.

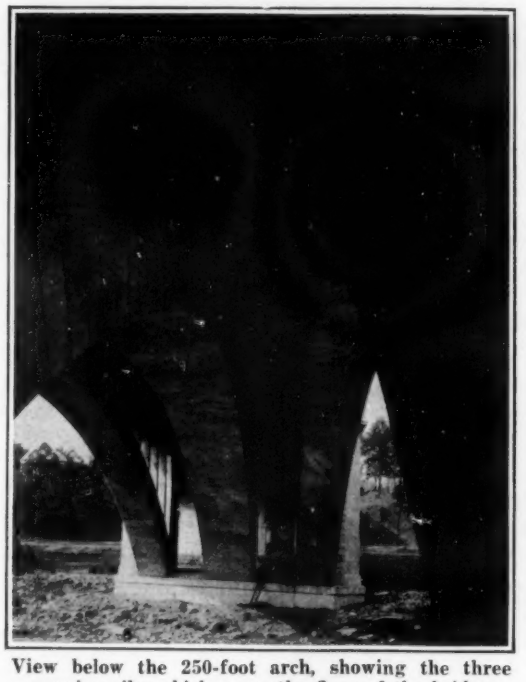
While the character and design of the entire bridge is of a decided memorial nature, the distinctive memorial features are embodied in large bronze tablets placed on four monumental pylons or shafts. There are four of these large bronze tablets, all 9 feet high by 5 feet wide, and each with a different inscription. One tablet commemorates the Revolutionary War, one commemorates the War of 1812, the Mexican, Civil and Spanish-American Wars, and two tablets commemorate the World War, one having the names of the great battles in which Delaware Troops fought, and the other bearing the names of all those service men from the entire State of Delaware who made the supreme sacrifice in the last Great War.

There are eight of the large, ornamental pylons or shafts placed on the bridge in line with the railings. Four of the larger shafts are placed over the piers of the large central arch and two of the smaller shafts at each end of the bridge. The large shafts extend 40 feet above the sidewalk level and the smaller shafts 23½ feet. The bronze tablets are placed on the inside faces of the shafts where they can be viewed by pedestrians on the sidewalks. On the inside faces of the smaller shafts are placed bronze nameplates measuring 3 feet by 4 feet. On each side of the large shafts and on the approach sides of the small shafts are placed large ornamental bronze lanterns, which are illuminated by a single incandescent Mazda lamp of 250 candlepower. On the inside and outside faces of the large shafts are placed carved Onondaga Litholite eagles and shields of a monumental character.

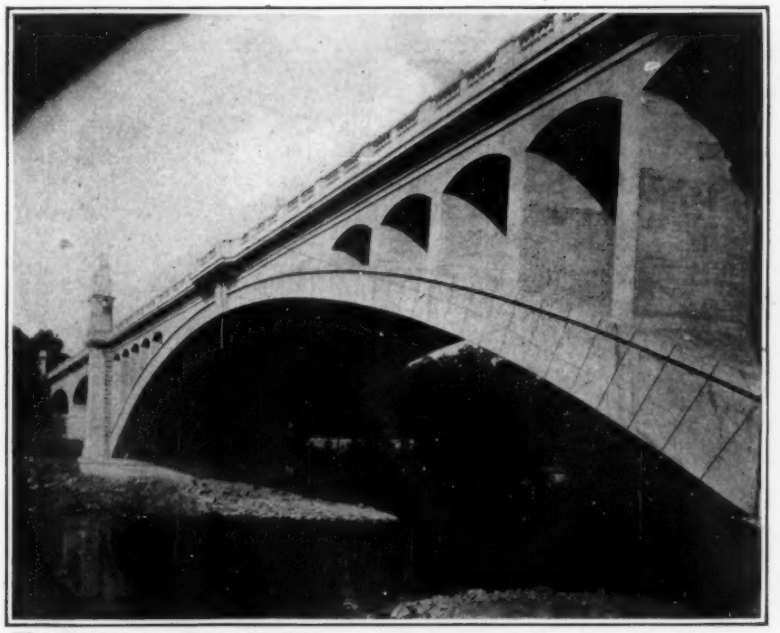
At the center of the span of the large arch a refuge bay was provided on both sides of the bridge by extending the sidewalks slightly beyond the line of the railing, thus forming a vantage point from which pedestrians might pause and view the park below. Refuge bays were also provided at both ends of the bridge. Large ornamental precast stone urns were placed on the end posts of the railing of the refuge bays at the north end of the bridge. The lighting system of the bridge was arranged so as to harmonize with the pylons and railings from an architectural standpoint, as well as to give the proper lighting effect to the sidewalks and roadway at night. The main lighting system consists of twenty-eight luminous arc lights supported by cast-ifon light poles placed on the curb line of the bridge. The secondary lighting system consists of the incandescent Mazda lamps in the twelve large bronze lanterns placed on the shafts and the two bronze standards at the stairway. The two lighting systems are on independent circuits.

The bridge was designed to carry the heaviest modern highway traffic, and liberal provision was made for impact and possible future increases in traffic requirements. The assumed loads used in the design were 60-ton electric railway cars placed on the double tracks, a line of 20-ton motor trucks on the roadway at each side of the tracks and a sidewalk load of 100 pounds per square foot.

The designs for the bridge were prepared by Mr. Benjamin, H. Davis, Consulting Engineer of New York City, assisted by Mr. Vance W. Torbet, Architect. Mr. Davis informs us that the cost of making a purely utilitarian bridge further serve as a war memorial was, in this case, approximately $56,550, this being less than 8 per cent of the entire cost of the structure. A memorial bridge daily serving the needs of a community yet at the same time commemorating the unselfish services of these citizens who rallied to the aid of their country in her hour of need, offers to cities and towns a fitting and economical solution of their war memorial problems.



View below the 250-foot arch, showing the three massive ribs which carry the floor of the bridge



The Washington Memorial bridge at Wilmington, dedicated to the Delaware soldiers and sailors of the Nation's wars from the founding of the Republic to the World War

Human Behavior and Reflexes

THE basis of nervous activity is formed by so-called reflexes and instincts. The instincts are complex reflexes. The instincts—inborn associations with definite stimulators—correspond to the activities of the organism. On this basis are built the highest nervous activities.

If the action of any indifferent agent coincides in time with the action of an instinct, and if the action of the agent is repeated many times, then this agent, formerly indifferent, begins to stimulate the instinct. For example, food stimulates the food reaction, which consists of some movements of the animal, and secretion. But if some indifferent agent, which previously had nothing in common with feeding, is repeated many times with the feeding, after a time it begins to stimulate the food reaction when used alone. Thus, if we produce some distinct musical sound at a given rate of frequency of vibration per second—and always at the same time feed a dog, after a while this sound, used alone, will produce the same food reaction as the food itself. Such stimulators may be formed from any agent of the outer world and with any other instinct. In this way, besides the reflexes or instincts which are inborn, some reflexes are acquired during the life of the individual. The first, or inborn, reflexes we call unconditioned reflexes, and the second, or acquired, reflexes we call conditioned.

It is clear that the conditioned reflexes play a very important part in our behavior, as they are being acquired during the entire life-time of the individual.

Conditioned stimulators serve as signals separate from the unconditioned stimulators, but, like any other signals, they may not signalize properly. Then they are to be corrected. For instance, in the experiments mentioned, the sound produced by one thousand vibrations per second was made a conditioned stimulator. If the sound is repeated without the simultaneous feeding of the dog, then for some time the sound loses its stimulating action. But this need not destroy the conditioned reflexes, for sometimes the stimulating action returns again. Secondly, if the conditioned stimulator is combined with another agent—any other agent—and is not at the same time combined with feeding, then the conditioned reflex loses its stimulating action. In both these cases we deal with inhibition. In this way the process of inhibition always accompanies the activity of the highest nervous centers.

The process of inhibition exists, also, for another end. It helps to differentiate the various stimulations from the outer world. For example, let us form from the sound caused by one thousand vibrations per second a conditioned stimulator for the food reaction, which means that this sound always produces the ordinary food reaction or the secretion of saliva. After this secretion reaction is formed to this particular sound all the sounds of the neighboring frequencies, say, 960 vibrations or 1100 vibrations, will also produce the same effect; that is, all the sounds of nearly the same frequency acted as stimulators for food reaction. If, however, we always produce only sounds caused by one thousand vibrations with the feeding of the dog, carefully excluding all the other sounds, after a time all the other sounds will lose their stimulating action and only the one sound will act as a stimulator for the food reaction. It is in this way that the limit of the differentiating ability of the dog or of any other animal may be very easily found.

Conditioned reflexes and differentiation make up the whole activity of the nervous system. It is also interesting to point out that recently we have proved that the process of inhibition is exactly the same process as that of sleep. The differentiating inhibition in sleep is divided into small parts, and sleep is diffused continuous inhibition. Thus there is no marked contrast between the normal, active state and the sleepy state.—*Abstract from article by Prof. I. P. Pavlow of Petrograd, Science, November 9, 1923.*

Farmyard Manure and Artificial Fertilizers

SIR JOHN RUSSELL, in discussing Agricultural Science as studied at the Rothamsted Experimental Station, said, in a lecture before the Royal Institution on February 9, 1923, concerning the difference between farmyard manure and artificial fertilizers: "Farmyard manure and also plant residues (which are substantially the same thing) decompose in the soil, giving rise to many substances of different types. The plant foods are among the end products; indeed, in natural conditions, and, to a large extent, in farms and gardens also, it is in this way that plants obtain their food. In using artificial manures we supply these end products at once instead of waiting for them to be liberated gradually by the natural decomposition. Further, we do not by any means know the whole of the processes whereby plant food is made. But there are certain intermediate products, and it is quite possible that some of these may have a special effect on the growing plant. Curious stimulating effects are produced by substances formed when soil is steamed, or when oxidation is accelerated by addition of charcoal, and small quantities of picric acid."

Post-Treaty Standing of the World's Navies

The Urgent Need for Additional Unarmored Craft to Round Out the U. S. Navy

THE Washington Treaty of Naval Limitation will always be regarded as one of the greatest works of constructive statesmanship in the world's history. At a single stroke, it killed a vicious and mendacious propaganda, which was producing that combination of suspicion, fear and hatred whose natural and inevitable child is war. By the terms of the treaty, the United States, Great Britain, Japan, France and Italy agreed to avoid any ruinous competition, and reduce their enormous and costly battleship fleets to a ratio of strength of five for the United States, five for Great Britain, three for Japan, 1.7 for France and 1.7 for Italy. Under the treaty, the tonnage allowable for the United States is 18 battleships of 525,850 tons total displacement, for Great Britain 20 battleships of 582,725 tons, (to be early reduced to 18 ships and 525,850 tons) and for Japan 10 battleships of 313,300 tons. All armored ships, both dreadnaughts and predreadnaughts, not included in the above totals, were to be destroyed, as were also all armored ships that were being built and were not yet completed. Furthermore, no new battleships were to be built for a period of ten years.

THE drawing on the opposite page represents the relative strength of the leading Navies of the world in unarmored ships. No battleships or battle cruisers are shown; the Washington Conference having determined a ratio in these ships of 5-5-3-1.7 and 1.7 respectively for the United States, Great Britain, Japan, France and Italy. Of light cruisers, flotilla leaders, and destroyers it was proposed that the United States be allowed 450,000 tons, Great Britain 450,000 tons, Japan 270,000 tons and France and Italy proportionately. In submarines the proposed totals were 90,000 tons, 90,000 tons, 54,000 tons and so forth. Ultimately, these restrictions on unarmored craft were abandoned. It will be seen that the United States Navy suffers from a very great shortage in light cruisers and possesses not a single flotilla leader.

Subsequently, at the urgent request of the Japanese, the battleship "Mutsu," (of about the same size and power as the "Maryland") which was practically completed, was permitted to remain on the Japanese lists, on condition that the United States be permitted to complete two ships of the "Maryland" class, and that Great Britain be allowed to build two battleships up to the limit of 35,000 tons imposed by the treaty. In order that the total limitations of battleship displacement be not exceeded, the three nations were required to destroy certain of their older battleships as soon as these additional ships were completed.

Most important in its effect on the cost of Naval armament was the reservation regarding the size of future capital ships, which as we have said, was placed at 35,000 tons. The rapidly increasing size of the battleship and battlecruiser, was one of the most alarming facts of the Naval problem. Under the spur of competition each Navy aimed to outbuild the existing ships of other Navies in speed, gun power, protection, steaming radius, etc.; with the result that the displacement had moved up in ten to twelve years' time from the 20,000-ton "North Dakota" to the 28,000-ton "Queen Elizabeth," the 32,600-ton "Maryland" and the 42,000-ton "Hood." Henceforth preponderance of power can no longer be obtained by large increases of displacement. The most effective battleship built under the treaty will be the one which combines in the best proportions the various elements of power above enumerated.

It was the aim of the sponsors for the Naval treaty to make it apply to all classes of fighting craft; but because of certain opposition that developed, the limitation clauses were not made to extend in any such sweeping measure to unarmored craft or as they were termed "auxiliary fighting craft." In the agreement, the last named were divided under three heads, auxiliary surface craft, submarines, anti-aircraft carriers and aircraft. Under surface fighting craft are included cruisers (with the exception of battle cruisers), destroyer flotilla leaders, destroyers and all other surface types (except existing monitors and unarmored surface craft under 3000 tons) fuel ships, supply ships, tenders, repair ships, mine sweepers and merchant vessels readily converted into vessels of war. It was proposed that the total tonnage of cruisers, flotilla leaders and destroyers allowed each power should be: United States and Great Britain each 450,000 tons, Japan 270,000 tons. The allowance of submarines was for the United States and Great Britain, each 90,000 tons, and for Japan 54,000 tons. Of aircraft carriers the United States and Great Britain were each allowed 80,000 tons and Japan 48,000 tons. Because of the fact that Naval aircraft may be readily adapted from special types of commercial aircraft, Congress did not consider that it was practical to prescribe any limit for these.

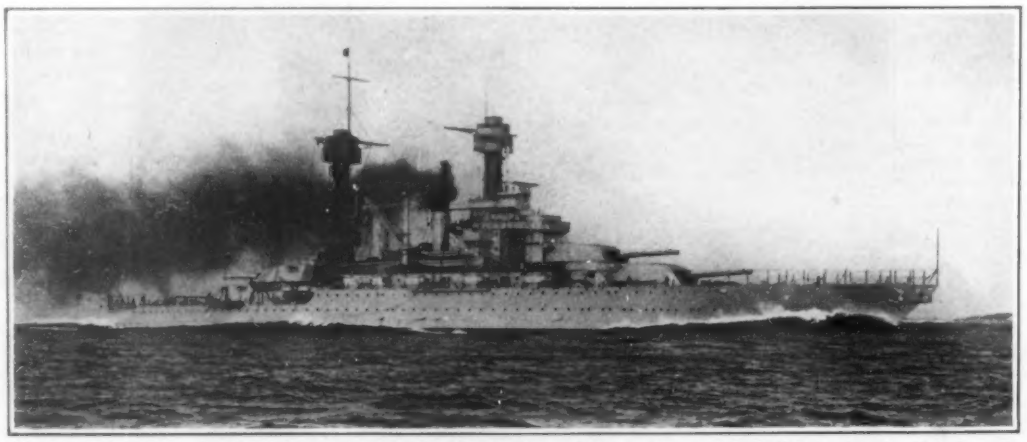
Unfortunately, in the discussions that followed the proposals as to cruisers and other auxiliaries, the restrictions as to these auxiliary craft were abandoned.

On the adjoining page is shown the present unarmored strength of the Nations that have signed the Naval Treaty. It serves to show at a glance where the United States is strong and where it is weak in the various types of vessels dealt with. The most important ships are those in the upper half of the page, which are grouped under the caption "first-line ships." Of equal importance, perhaps, (Admiral Sims and a few others of our Naval officers would say of greater importance) are the ships shown with the caption "aircraft carriers." The second-line ships, because of their age, are of minor importance.

Frequently during the past twenty years, the SCIENTIFIC AMERICAN has urged that our Navy is top-heavy, in so far as we have put our displacement into battleships to the neglect of other types. The most serious weakness of our fleet is our shortage of fast light cruisers of 8000 tons and over. Unless we include the ten vessels of the "Richmond" class, which, although they were designed to be of 7500 tons displacement have been so greatly increased in armament (50 per cent increase) and in strength of hull, that they displace today about 9000 tons—we have no light cruisers of the first class. However, we have put these ten ships in the class of light cruisers of from 3000 to 8000 tons, and this leaves us without any in the 8000 tons plus class, in which the British have six ships, Japan four, France three and Italy two. In the 3000 plus class, we have these ten ships, and it is some consolation to know that in speed and power (each carries 12 six-inch guns) they are incomparably superior to ships of the same class in other Navies. Great Britain has 35 ships in the 3000 plus class; including many fine and modern vessels; but a considerable proportion of them are rather old as vessels go. Japan has 23 ships; France has three, and Italy five. When we come to destroyer leaders, we are hard hit; for we have not a single vessel of this most important class; whereas Great Britain has 18, France seven and Italy eight.

In the class of 800 to 1500-ton destroyers, we have a most impressive lead, all of our ships being newly built during the war and showing a speed on trial of 34 to 35 knots. In submarines of 500 to 1000-tons displace-

(*Continued on page 367*)



Displacement, 32,600 tons. *Speed*, 21.37. *Guns:* Eight 16-inch; twelve 5-inch. *Armor:* Belt, 13½-inch; turrets, 18-inch to 9-inch; torpedo tubes, 2 submerged

Our latest Battleship "Colorado"

Our Latest Battleship—the "Colorado"

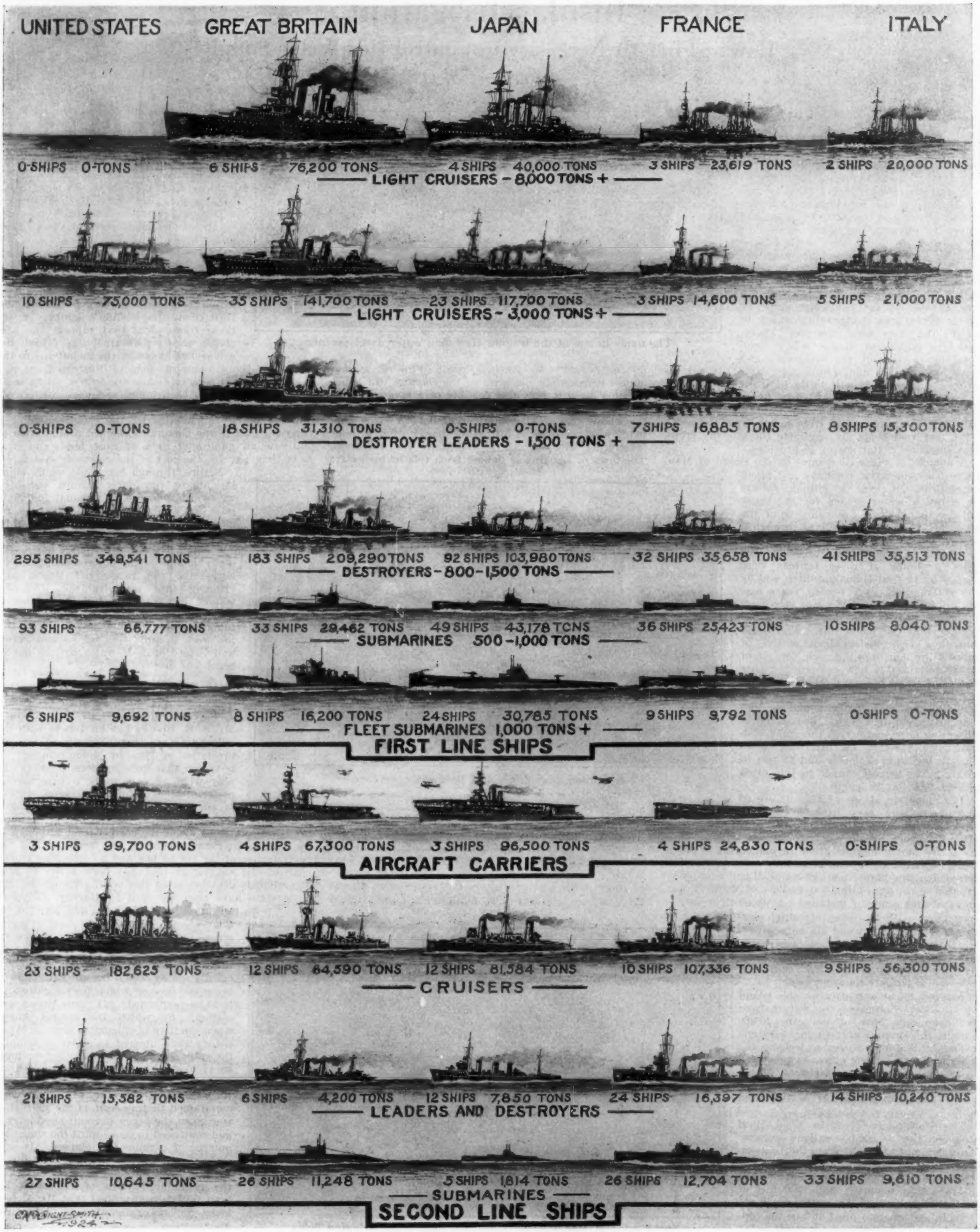
THERE are many facts connected with the United States battleship "Colorado" which make her of special interest to the American public. In the first place her displacement of 32,600 tons (normal) renders her the biggest battleship afloat, a distinction which she shares with her two sister-ships, the "Maryland" and "West Virginia." The British "Hood" is larger by 9800 tons; but she is more battlecruiser than battleship and indeed is so listed by the British themselves.

Not only is the "Colorado" the largest, but she is among the most heavily armed battleships, since she carries eight 16-inch 45-caliber guns. This is a more powerful battery than that of the "Royal Sovereign" and "Queen Elizabeth" classes, which mount eight 42-caliber 15-inch guns as their main armament. Another point of superiority is the defensive arrangements of the "Colorado," both as regards heavy armor and under-water subdivision. The armor plan includes 13½-inch side armor, 18 to 9-inch turret armor, and heavy armor around the bases of the smokestacks. The under-water protection is superb; the hull between the engine rooms and the water being made up of no less than five separate water-tight shells (longitudinal bulkheads) designed to receive the blow of the torpedo and dissipate the disruptive power of its gases before they can get through to the engine rooms, the boiler rooms, the magazines, or other vitals of the ships.

The speed of the "Colorado" in her recent trials over the official measured mile at Rockland, Maine, was 21.37 knots. Before undergoing these trials, she was sent on a shaking-down trip to Europe, where she attracted wide attention and was a subject of very favorable comment. She is indeed a very handsome and imposing ship. With her long and lofty spar deck, towering bridge structure, and formidable looking housed-in tops, she presents a truly majestic Naval picture.

If we have any criticism to make of the "Colorado" and her sisters, it is that too much of their armor is vertical and too little of it horizontal. A few inches taken from the side armor and judiciously placed above the magazines, would render these ships better protected against the steeply falling shells of a long-range bombardment. Similarly a few inches taken from the port plate of the turrets and placed upon the roofs, would render the sixteen-inch guns more secure than they are now against turret penetration. However, all existing ships in any Navy of the world are open to the same criticism.

Another interesting fact about the "Colorado," is the fact that she is the last battleship that we shall build for some years to come, that is to say, until the Washington Treaty Limitation has expired. The limit of size of that treaty is expressed in displacement, and it stands at 35,000 tons. Great Britain, as an offset to our completion of the "Maryland" class, was permitted to build two battleships.

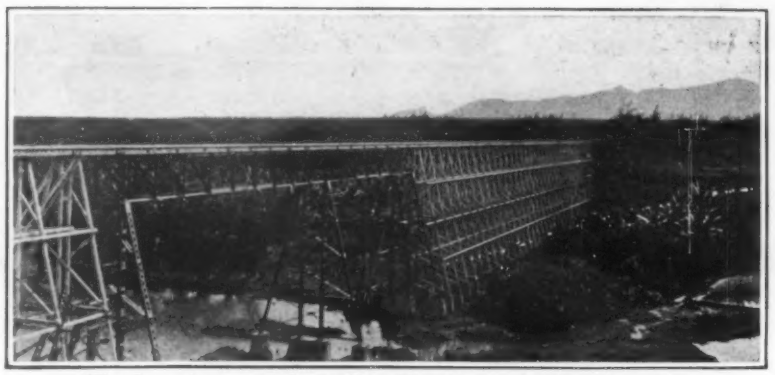

UNITED STATES
GREAT BRITAIN
JAPAN
FRANCE
ITALY
0 SHIPS 0 TONS
6 SHIPS 76,200 TONS
4 SHIPS 40,000 TONS
3 SHIPS 23,619 TONS
2 SHIPS 20,000 TONS
LIGHT CRUISERS - 8,000 TONS +
10 SHIPS 75,000 TONS
35 SHIPS 141,700 TONS
23 SHIPS 117,700 TONS
3 SHIPS 14,600 TONS
5 SHIPS 21,000 TONS
LIGHT CRUISERS - 3,000 TONS +
0 SHIPS 0 TONS
18 SHIPS 31,310 TONS
0 SHIPS 0 TONS
7 SHIPS 16,885 TONS
8 SHIPS 15,300 TONS
DESTROYER LEADERS - 1,500 TONS +
295 SHIPS 349,541 TONS
183 SHIPS 209,290 TONS
92 SHIPS 103,980 TONS
32 SHIPS 35,658 TONS
41 SHIPS 35,513 TONS
DESTROYERS - 800 - 1,500 TONS
93 SHIPS 66,777 TONS
33 SHIPS 29,462 TONS
49 SHIPS 43,178 TONS
36 SHIPS 25,423 TONS
10 SHIPS 8,040 TONS
SUBMARINES 500 - 1,000 TONS
6 SHIPS 9,692 TONS
8 SHIPS 16,200 TONS
24 SHIPS 30,785 TONS
9 SHIPS 9,792 TONS
0 SHIPS 0 TONS
FLEET SUBMARINES 1,000 TONS +
FIRST LINE SHIPS
3 SHIPS 99,700 TONS
4 SHIPS 67,300 TONS
3 SHIPS 96,500 TONS
4 SHIPS 24,830 TONS
0 SHIPS 0 TONS
AIRCRAFT CARRIERS
23 SHIPS 182,625 TONS
12 SHIPS 64,590 TONS
12 SHIPS 81,584 TONS
10 SHIPS 107,336 TONS
9 SHIPS 56,300 TONS
CRUISERS
21 SHIPS 15,582 TONS
6 SHIPS 4,200 TONS
12 SHIPS 7,850 TONS
24 SHIPS 16,397 TONS
14 SHIPS 10,240 TONS
LEADERS AND DESTROYERS
27 SHIPS 10,645 TONS
26 SHIPS 11,248 TONS
5 SHIPS 1814 TONS
26 SHIPS 12,704 TONS
33 SHIPS 9,610 TONS
SUBMARINES
SECOND LINE SHIPS
WRIGHT-SMITH 1924

Insular Irrigation

Hawaii Finds It Necessary to Control Her Water Supply

By Arthur L. Dahl

WHEN we think of Hawaii we are apt to consider it the garden spot of the world, where Nature has arranged everything to produce the most luxuriant growth with the slightest effort of man. This is true to a limited extent, for climatic conditions are ideal for most tropical crops, but the ingenuity of man has been called into play to insure, in many parts of the islands, the necessary irrigation waters for the fields of sugar cane, rice or other native products, for while copious rains fall in the high mountains some of the low lands do not get a sufficient supply of water throughout the growing season to supply the crops with moisture. Therefore, the plantation engineers have gone into the recesses of the mountains and have built flumes and conduits to carry the surplus waters to where they will do the most good.



The flume in one of the leading Hawaiian water developments

Hawaii is a country of contrasts, for at many points towering mountains rise almost out of the sea, while at others the sandy shore rises slowly from the ocean level, and vast fields are available for growing crops, if a sustained water supply is provided.

A number of sugar companies on the island of Maui formed a cooperative company and at an expenditure of over a million dollars developed a water system for the sugar fields that brings the rains from the mountain slopes of East Maui through a system of canals and tunnels over 40 miles long to irrigate the cane fields. The more available of these sources were tapped by the old Hamakua ditch and by the Haiku ditch over twenty years ago, but as the need for more water increased, the ditch system penetrated many miles further into the mountains. The latest Kauhikoa ditch consists almost entirely of tunnels through the solid rock, for out of 23,500 feet of this new construction only 700 feet consists of open ditch, the remaining 22,800 feet being beneath the surface. The ditches are six feet wide and the tunnels are seven feet high. The water in this ditch is passed across the great Maliko gulch through an inverted siphon pipe 22 inches in diameter and 85 feet in length. The longest tunnel on this ditch is over 3000 feet in length.

Irrigation ditch through a field of sugar cane

The mountain slopes of Hawaii are so precipitous that very little of storage facilities is afforded, and during the middle of the dry season it is often necessary for the sugar companies to supplement the water supply obtained from the mountains by pumping water from wells sunk at various points throughout the fields. One plantation has installed pumping plants capable of raising 30,000,000 gallons of water a day, and the same company installed a hydroelectric plant in connection with its mountain ditch system capable of generating 875 horsepower, which power was used to operate pumps that elevated 6,500,000 gallons of water daily to a height of 574 feet, and then released to irrigate the cane fields.

Another sugar company on the island of Maui has harnessed the waters from the mountains back of the cane fields, and in the process of bringing 5,000,000 gallons of water each day to irrigate the land, sufficient electric power is generated by the falling waters to light all of the plantation buildings and supply power to pump 1,500,000 gallons of water from wells.

The Honokahau ditch in West Maui supplies about 50,000,000 gallons of water daily, which is brought from the Honokahau Valley, a distance of some seven miles. The canal consists of 6½ miles of tunnels, 400 feet of open ditch, and 1200 feet of 36 inch siphon pipe. The entire ditch and tunnels are concrete lined and in the construction of this system many engineering difficulties had to be overcome, owing to the rugged and almost inaccessible character of the country. In building this ditch it was also possible to generate electric current, for one of the ditches reached the plantation far above the area of cultivation, and a generating plant was installed to utilize the power drop without interfering with the use of the water for irrigation. The town of Lahaina is lighted from this hydroelectric power plant, and there is plenty of current to spare.

The cane fields of the Hawaiian Commercial and Sugar Company, the largest sugar company in the islands, are watered principally by a great canal and ditch which brings water from the mountains of East Maui, a distance of over 50 miles. The upper reaches of these mountains are rain-soaked practically all the time, and by a system of four ditches heading into the wet area a constant supply of water is obtained and carried to the drier region below. Practically all of the ditch line is made up of tunnels, which are cement lined, and cost over half a million dollars to construct. To supplement the water supply during the periods when the rains fail, the company has developed a system of pumping plants to take water from the many subterranean reservoirs which lie under the fields.

In the process of bringing irrigation waters to the low lands, some of the companies have found it necessary to construct long trestles to support the flumes across canyons or low depressions, and throughout the islands visitors can see these frameworks that support the lifegiving waters that are brought from the rainsoaked slopes of the mountains to the dry areas below. One of them is illustrated.

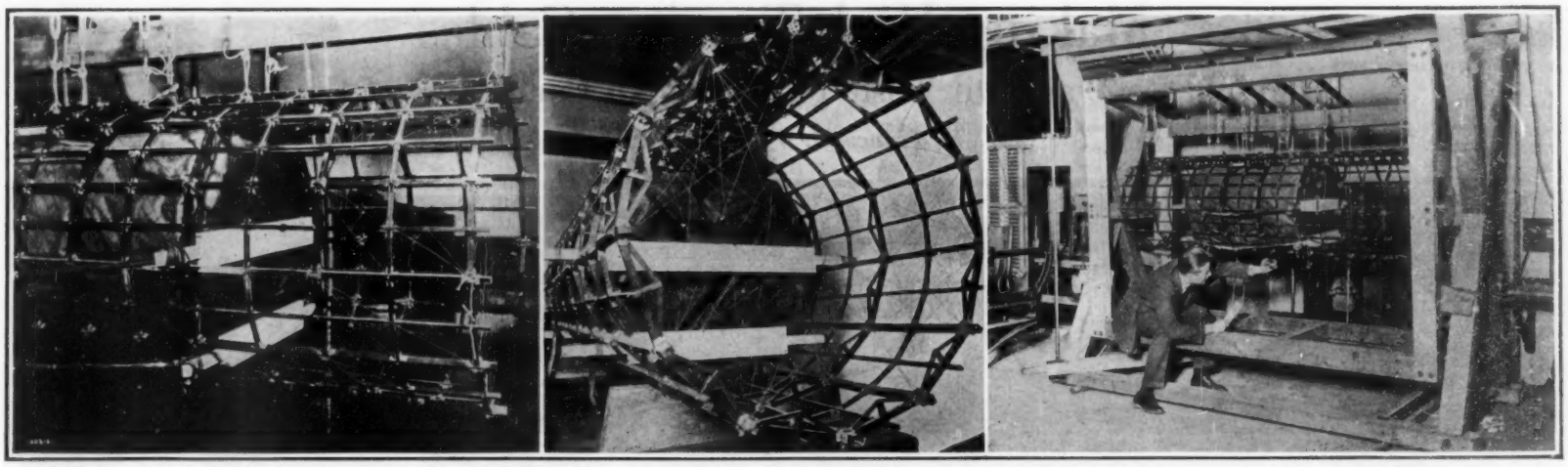
While natural reservoir sites are scarce, yet in some instances these have been found and have been developed to regulate the flow of irrigation waters throughout the year. In one district the construction of a reservoir high in the mountains enabled a plantation to cultivate an additional area of cane land, and thus more than pay for the cost of the reservoir system.

Nature, through her trade winds blowing almost constantly against the high westward sides of the mountains, supplies an excessive rainfall to those regions, while on the low lands protected by the shoulder of those same mountains, the sun shines without interruption during the many months of the dry season. Man, by harnessing the rainsoaked slopes, and bringing into captivity the lifegiving waters, has made the low lands blossom with sugar cane and rice, and the other things which furnish food for people, and the work is still going on, so that eventually every drop of water will be put to beneficent use.

Sugar mills at Hakalau, deriving their cane from irrigated fields

The Sense of Time

IN the Proceedings of the Society for Psychical Research (British) for July, Mr. S. E. Hooper has an article with the title "An Experimental Study of the Appreciation of Time by Somnambules." It is known that some hypnotic subjects display what appears to be a supernormal power of appreciating the passage of time. If, for example, such a subject is told during hypnosis to perform some simple act at the end of 5000 minutes he will do so, at or about the correct time, although in the period intervening between the hypnosis and the performance of the act he has had no conscious knowledge of the suggestion that has been given to him. Experiments demonstrating this peculiarity of the hypnotic state have been recorded by Gurney, Delboeuf, Bramwell, and Mitchell, and Mr. Hooper takes up the inquiry at the point at which it was left by these observers. Two main problems are presented by the results of these experiments: (1) the subliminal calculation by which the subject comes to know the time at which the suggested act is to be performed; (2) "true time-appreciation," by which the subject knows when the time so calculated arrives. When a long time-interval is given in minutes the subject usually calculates subliminally so as to find out when the suggested act falls due. Mr. Hooper's experiments corroborate this; but one of his subjects maintained that as soon as the suggestion was given she began to count rhythmically and continued to do so until the suggested number of minutes had elapsed. It is to such a capacity for accurate counting of seconds by a subconsciousness on which the pendular rhythm of the clock has been faithfully inscribed that Mr. Hooper looks for an explanation of "true time-appreciation."



Three views of the celluloid model of the "Shenandoah," used in the novel stress tests. Polarized light is passed through the various members while under stress, and the nature and magnitude of the pull or push which they must withstand is shown by the rainbow colors of the resulting image

Translating Stresses Into Color for Visual Observation

THE Bureau of Aeronautics of the Navy Department has made a study of a celluloid model of the airship "Shenandoah" by means of photoelastic methods. The work was done in the laboratories of the Massachusetts Institute of Technology. No definite statement of the results of the tests can be made but Navy Department officials have expressed themselves as well pleased with the data obtained. It is believed that these tests will be of "distinct value" and of material aid in the design of airships to prevent a repetition of the "ZR-2" and "Roma" disasters.

The model consists of several thousand pieces of celluloid machined precisely to scale and fitted together in a miniature duplicate of the airship. The testing was performed in the photoelastic laboratory of the Department of Physics by Dr. Paul Heymans and T. H. Frost, of the Technology staff, under the general supervision of Professor Charles L. Norton of the Department of Physics.

The phenomena of photoelasticity have been known to science for some time, but have been employed only recently to settle troublesome problems of structural design, many of which cannot be mathematically determined. By this method polarized light is passed through the celluloid of the model under different loading conditions, and the stresses appear in rainbow colors. Since celluloid acts structurally as do metals used in construction, it is possible by varying the loads on the laboratory model, to determine just how the airship itself will act under various conditions.

As Prof. Heymans states: "By this photoelastic method we can look into the vast and intricate network of the dirigible and see exactly what is going on when it is laboring. We can see how she is carrying and distributing the load. We have made an analysis of the 'Shenandoah,' saying exactly how the stresses are taken up by the members of the frame and the wires. When we hear of new forces which the ship must meet in its ventures overhead we can try them out on the model here at Technology."

Vision and Man's Mental Powers

THE first step in the evolution of man's mental powers was taken when, in a very primitive and unspecialized arboreal mammal, vision became the dominant sense, by which movements were guided and behavior was largely determined. One of the immediate results of the enhancement of the importance of vision was to awaken the animal's curiosity concerning the things it saw around it. Hence it was prompted to handle them, and its hands were guided by visual control in doing so. This brought about not merely increased skill in movement, but also the cultivation of the tactile and kinæsthetic senses, and the building up of an empirical knowledge of the world around it by a correlation of the information obtained experimentally by vision, touch and movement. The acquisition of greater skill affected not merely the hands but also the cerebral mechanisms that regulate all movements; and one of the ways in which this was expressed was in the attainment of a wider range and an increased precision of the conjugate movements of the eyes, and especially of a more accurate control of convergence. This did not occur, however, until the flattening of the face (reduction of the snout) allowed the eyes to come to the front of the head and look forward so that the visual fields overlapped. Moreover, a very complicated mechanism had to be developed in the brain before these delicate associated movements of the eyes could be effected. The building-up of the instrument for regulating these eye-movements was the fundamental factor in the evolution of man's ancestors, which opened the way for the wider vision and the power of looking forward that are so pre-eminently distinctive of the human intellect. Our common speech is permeated with the symbolism that proclaims the influence of vision in our intellectual life.

The first stage in this process seems to have been the expansion of the prefrontal cortex and the acquisition of the power of voluntarily extending the range of conjugate movements of the eyes and focusing them upon any object. Then came the laborious process of building up in the mid-brain the instrument for effecting these complex adjustments automatically, so that the animal was then able to fix its gaze upon an object and to concentrate its attention upon the thing seen rather than upon the muscular act incidental to the process of seeing it. This represents the germ of attention and mental concentration in general. But the power of automatically moving the eyes with such accuracy that the images of an object upon the two retinæ could be focused with precision upon exactly corresponding spots made possible the acquisition of stereoscopic vision, the ability to appreciate the form, size, solidity, and exact position in space of objects. Hence, at this time probably for the first time in the history of living creatures an animal acquired the power of "seeing" in the sense that we associate with that verb. The attainment of these new powers of exact vision further stimulated the animal's curiosity to examine and handle the objects around it and provided a more efficient control of the hands, so that acts of increasing degrees of skill were learned and much more delicate powers of tactile discrimination were acquired. Out of these experiments also there emerged a fuller appreciation of the nature of the objects seen and handled and of the natural forces that influenced the course of events.—*Abstracts from address by Professor G. Elliot Smith, F. R. S., before the British Association, September, 1923.*

Submarine photograph taken from high in the air

Under-Water Photographs from the Air

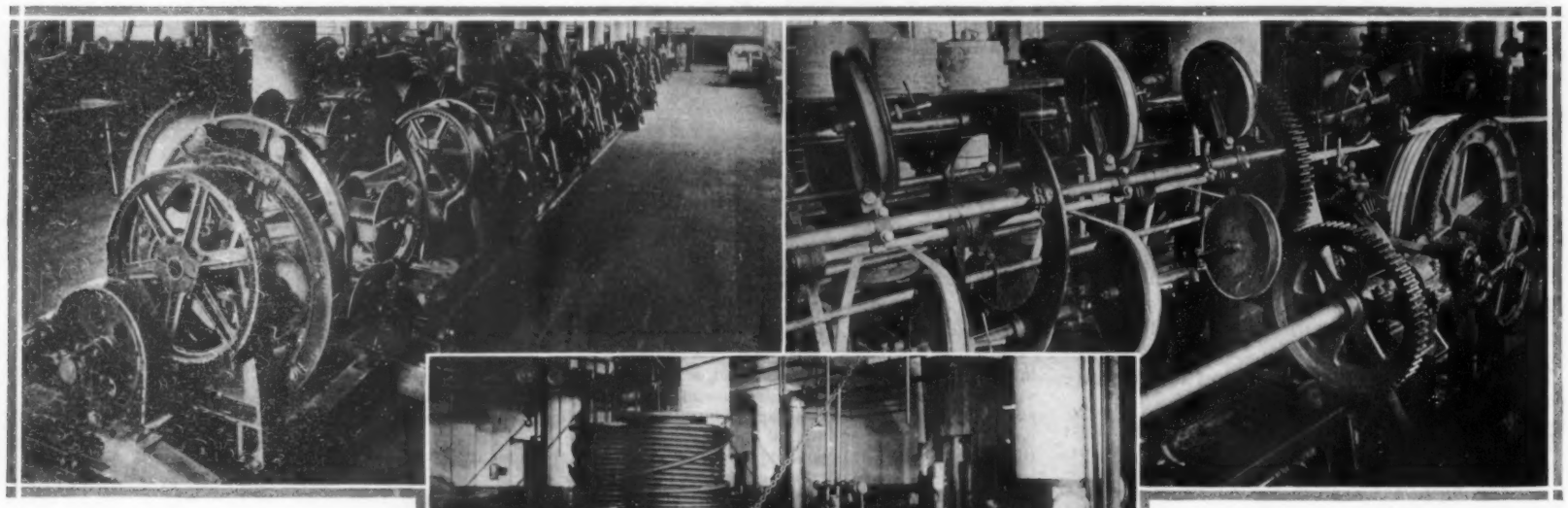
THE airplane has opened up new worlds. One of them is a submarine world. Aviators flying hundreds of feet above a body of water can see submerged objects far beneath the surface. That is why aircraft were the deadly enemies of submarines during the late war, and why airplanes are now used to locate shoals of fish.

And the camera, when equipped with the right kind of plates and ray filters, can penetrate the water even more successfully than the human eye. Objects submerged more than fifty feet have been photographed from an airplane. Hence it is now possible to make a rapid photographic survey of shoal waterways. Rivers like the Mississippi, with ever shifting bars, will hereafter be made safe by monthly or weekly mapping from the air. In earthquake regions, such as southern Italy and Japan, the changing coast line, shallows and harbors can easily be photographed after each new quake, thus keeping navigation open and conserving lives.

Making High-Tension Cables

From Old Rope and Oil Waste to Leak-Proof Conductors of Current

By Francis A. Westbrook, M.E.



Left: The sector stranding machine, which coils the individual strands of wire into cable. *Right:* Winding the paper insulation off its spools and on to the cable. *Below:* The impregnating tanks

Three stages in the manufacture of paper-wound, oil-impregnated, electric cable for underground transmission of current

ELECTRICAL conductors strung on poles along city streets are often the object of condemnation by shade tree commissions, improvement societies and others and that is about all the thought that is given to the subject of electrical transmission and distribution by the general public, except when something goes wrong and the lights go out. When once the conductors are placed out of sight below the surface of the ground everybody heaves a sigh of relief and forgets about them except the engineers who have to transmit the power over them and the manufacturers who have to make them.

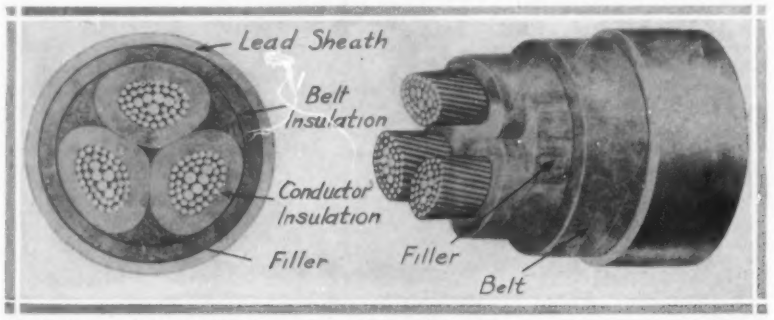
The engineers worry because it is becoming more and more of a problem how to carry efficiently the immense blocks of power which must somehow be conveyed from the generating stations to supply the continually increasing demands of industrial and domestic consumers. When one of the very new modern generating stations is put into service, it is not so difficult to build a steel tower transmission line on private right of way as far as the city limits, but from there on to the various sub-stations, of necessity located in thickly populated areas, it is a very different matter. As no city will permit very high voltage overhead lines it is imperative to install the conductors underground, and this greatly complicates the problems of insulation.

It is not yet possible to make insulated cables for very high voltages when compared to those used for open wire lines. On the other hand, the voltage must be kept up reasonably high because it is not possible to transmit electrical power economically at low voltage. Consequently the central station engineers are clamoring for higher and higher voltage cables and the manufacturing engineers are wrestling with the problem of how to make them.

The highest voltage underground cables in commercial service are for 45,000, and some at 66,000 will soon be in operation; but even this is not very high when compared to the 220,000 volt aerial transmission lines now giving satisfactory results in California. In contradistinction to this the making of even 25,000 volt underground cables requires the greatest care and involves constant electrical and chemical research, not to mention the attention which must be given to the technique of actual manufacturing and testing before shipment.

It is a curious fact that the insulation for these cables is made out of old ropes and refuse from oil refining. To be more specific it is a rather heavy Manila rope paper wrapped tightly around the copper conductor in strips or "tapes," and saturated with heavy mineral oil that is worthless for ordinary uses.

The character of the paper used is the subject of much attention—it must be strong enough so that it will not tear when wrapped around the copper conductor with adequate tightness, or when the finished cable is bent as during the process of reeling or unreeling, or when being pulled into underground conduit. Furthermore, it must be capable of absorbing the proper amount of oil, or "compound," as it is generally spoken of, not only between the fibres of the paper but also within the fibres themselves. It must be free from injurious impurities, and have the necessary electrical characteristics such as low capacity, high dielectric strength, and low dielectric loss. Paper suitable for a certain voltage may not be suitable for a higher voltage. It must also be capable of withstanding a high degree of heat without charring or "carbonizing," as the cables become hot when carrying a heavy load. All this must be determined before the paper is used for every roll received from the mills, because it seems to be very difficult to make it of uniform quality and there are continual variations of one kind or another.



It will be seen that with this shape of stranded conductor, the inner wires are larger than the outer ones. Usually the strands are crushed together more than here appears. Note also the paper or jute "fillers" for taking up the space between the insulated conductors

Cross-section of sector cable

It is the same story with the impregnating compound. The material used is principally petrolatum—a product of the refining of crude oil; but the degree of refinement and the method of refining employed are of great importance. Not only is the insulating quality of the compound itself affected thereby but also the amount of it which can be absorbed by the paper. Furthermore, certain kinds of paper and certain kinds of compound go best together and the problem is to find the combination which will give the best results for any specified set of operating conditions. These petrolatum compounds, as well as the paper, vary a great deal from time to time even when there is no apparent reason why there should be any difference. Consequently these variations also have to be carefully ascertained by continual laboratory tests. Five tests on the paper, four on the oil, and three on samples of impregnated paper, made unremittingly, are the least number which will suffice to ensure good quality. At least twice as many tests have to be made at less frequent intervals.

The heating of cables while transmitting power has been mentioned. This is partly due to the number of amperes of current being carried and can be kept within reasonable limits by providing sufficiently large conductors. There is another cause of heating from the "dielectric loss" which occurs in the insulation and depends on the voltage and the nature of the insulating material. It is due to the electrical stressing of the insulation and the absorption of a certain amount of power.

The temperature at which a cable can be operated is limited by the amount of heat which the insulation can stand without charring. That is, no cable can be successfully operated continuously above a definite temperature. The heating caused by the current which is flowing is to be expected and is unavoidable, but that caused by the "dielectric loss" in the insulation, which has nothing to do with the current, but nevertheless reduces the number of amperes which can be carried, can be controlled to a considerable extent. The "dielectric loss" depends on the electrical properties of the paper and impregnating compound and knowing these from laboratory tests, it is possible to predict its magnitude. The insulating strength cannot be predetermined so easily but it is not entirely unpredictable. As regards the highest permissible temperature, this is limited by the properties of the oil and the paper. Consequently in designing a cable it is necessary to see that all the desirable characteristics will be attained with the utmost economy both from the standpoint of cost of raw materials and the facility with which they can be put through the manufacturing processes.

Having these requirements in mind let us now see how the cables are actually made. In the first place

there are two kinds of high tension cables—single conductor and triple conductor. Commercial transmission circuits are almost universally three phase and require three conductors. The three conductors may be twisted together and be placed within a common lead sheath so as to take up only one duct in an underground conduit line. This has very definite electrical advantages as the magnetic fields surrounding each current-carrying conductor are neutralized by their close proximity. But for very high voltages, say 45,000 between conductors, the insulation has to be so thick that, even if the proper manufacturing machinery were available and if the cables would not be too stiff to handle, it would still be impossible to group the three conductors under one sheath because the diameter would be so large that there is no conduit line in existence with big enough ducts to receive them. Consequently for voltages above 33,000, single-conductor cables are used.

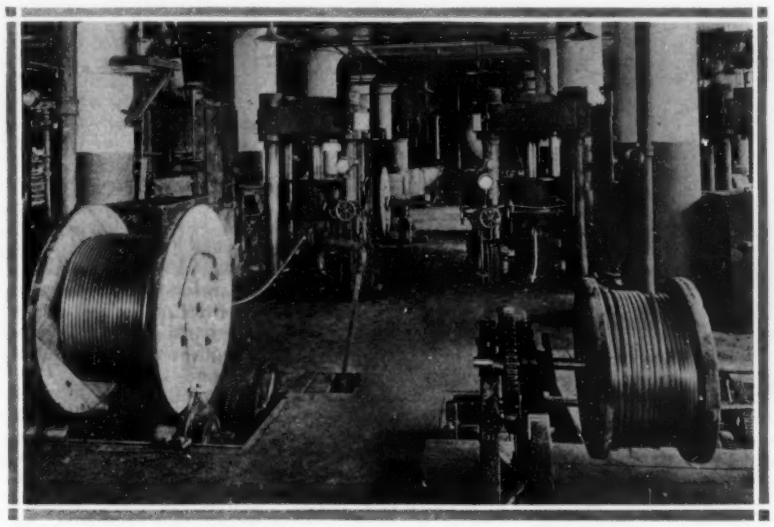
The conductors themselves are of stranded copper. In three-conductor cables they are generally "sector shaped," as shown in the drawing; for it is possible to have a smaller diameter in this way. With single conductor cables the conductors are, naturally, round. The sizes of the conductor of course vary depending on the amount of current to be carried but 350,000 circular mils is used more frequently than any other for three conductor cables and it is about the largest size practicable for very high voltages because, taken together with the thick insulation required, the final diameter will be the maximum which will go into existing duct lines.

The stranding operation for round and sector conductors is carried out by different machines but they both follow the same principles. Take for instance a 350,000 circular mil round conductor. This is made up of thirty-seven No. 9 A. W. G. soft copper wires, that is, three layers wound in reverse directions around the center wire. The stranding machine is very long and consists of sections which revolve in opposite directions. The proper number of coils of wire for each layer is mounted in each respective section of this machine. There are six for the first layer, twelve for the second layer and eighteen for the third. The six wires or strands are twisted around the center strand, then the twelve wires over it in the opposite direction by the second section of the machine, and the third layer is formed by winding the eighteen strands over this with the direction of winding again reversed. This is known to the cable manufacturer as "concentric" stranding.

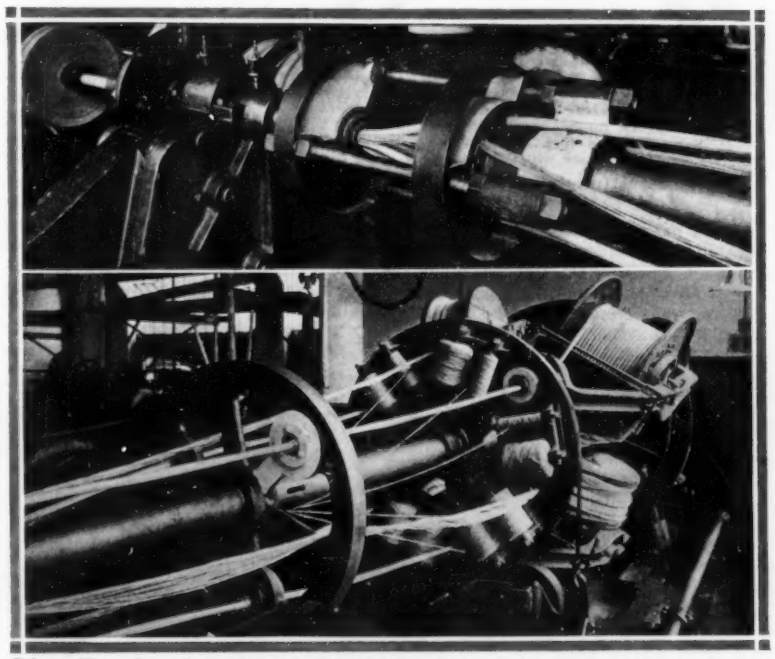
The sector stranding machine, shown on p. 324, also consists of parts revolving in opposite directions and in which coils of wire are mounted but in this case the strands in different layers are of different sizes, as the drawing indicates. This is simply because it is better for mechanical reasons to have the inner strands larger than the outer. That is, they shape up better and retain the sector form more securely than if they were all the same size.

The application of the paper insulation is by means of a rather simple machine, which we show, but, as in almost any manufacturing operation, is accomplished with the help of a good deal of technique acquired through much practical experience. As shown in the photo, the conductor passes through a long machine and as it does so the rolls of narrow paper tape revolve and wind the insulation about it. A certain number of tapes are usually wound on in one direction and are then reversed. As many as fifty layers can be applied at one passage through the machine, sometimes more if the machine is very large, and if a greater thickness of insulation is required, it will have to go through again. As the paper generally used is five thousandths of an inch thick, one passage through the machine means one-quarter inch of insulation, which is enough for about 20,000 volts. For very high voltages it may be necessary to run through the machine three or four times. The technique comes in in winding on the paper with sufficient tension to exclude air spaces between successive layers without tearing it. Another fine point is to have the spiral of each single tape with the specified uniform overlapping.

After the copper conductors have been covered with the required thickness of paper they are taken to the "cabling machine," if they are to be made into a three conductor cable. This is where they are twisted together, as shown below. It works on the same principle as a simplified stranding machine where there is only one layer. Three large reels of insulated conductors are mounted on the revolving part of the machine together with spools of jute or paper strips, called "fillers," which are fed into the spaces between the conductors as they pass through the die, thus giving a solid round cross-section to the assembled cable. The twisting of the conductors is accomplished by the turning of the machine. Here again the question of technique is encountered in the necessity of so operating the machine that the points of the sectors will actually always point toward the center. After passing through the die at the end of the machine, and as a part of the same operation, the assembled conductors are given, just as on the insulating machine, one or two windings of paper tape to hold them in place. This is the beginning of the "belt," or "jacket," insulation which may be completed at this point but is sometimes finished on another machine just as already described for the individual conductors.



The press through which the cable passes, after impregnation, to receive its coating of lead. Fed in at the back, it emerges at the front with the sheathing applied



Below: The reels, each carrying a single insulated conductor, and the spools of filler, in place on the machine. *Above:* Cables and filler converging into the die at the extreme left, just beyond which the first layers of the "belt" are being applied

The cabling machine, which twists the three conductors together, with the "fillers" for taking up the spaces between which would otherwise be void

The mention of the belt insulation brings up a subject which we have not yet considered. Each conductor has a certain thickness of paper around it so that the effective thickness between any two is twice that amount. This, of course, is designed to be adequate for the difference in voltage between conductors. But the amount of insulation between a conductor and the lead sheath of the cable, or ground, is only that around the individual conductor and as the voltage to ground is more than half the voltage between conductors, it is necessary to provide additional insulation. That is the function of the belt, common to all of the conductors. Of course, an equivalent thickness of paper could be wrapped around each conductor but that would increase the diameter of the cable and use up much more paper and consequently more impregnating material—that is, the cable would cost more to make and would also require larger diameter, therefore expensive, conduits. In fact, where cables are to be pulled into old conduit lines this question of keeping down the diameter is vital.

Of course with single conductor cables the "cabling" and "belt" operations are eliminated.

The cable is now ready for the impregnating department but before actual impregnation is begun certain preliminary steps are necessary. It must first be thoroughly dried. Even the driest appearing paper retains a surprising amount of moisture which if not removed very seriously diminishes its insulation strength. Dry looking paper contains, according to careful laboratory tests, about 4 to 5 per cent of moisture and ordinary paper as much as 7 or 8 per cent. Consequently the cable, on the reel as it comes from the insulating department and weighing perhaps five tons, is placed in a hot air oven where it is left for several days. This long continued heating, called "preheating," under conditions where the air in the oven is kept dry, removes most of the moisture.

The cable, still on its reel, is then moved into the impregnating tank, shown on p. 324, where the heating is continued for some time longer in vacuo. This removes whatever moisture remains along with the air from even the innermost strands of the conductors as well as from the tuberous fibers of the paper. The duration of preheating and heating in vacuo have been the subject of a great deal of experimentation, as a result of which sufficient data have been obtained to determine the proper periods for both treatments for the different kinds of paper, thickness of insulation, etc.

The impregnating compound is introduced into the tank while the cable is still hot and while the vacuum is maintained. After giving the compound an opportunity to soak into the insulation, a matter of from 12 to 30 hours, a high pressure is applied to drive it against capillary force into the channels of the paper fibers It seems almost incredible that the compound should penetrate through all the layers of paper and even in between the strands of the conductors but it is a fact that this does happen and it is very important that it should do so. As already explained, air ionizes under the electrical stresses in high tension cables and causes deterioration of the insulation, so that it must be entirely removed and kept out. The only way to do this is to fill completely every pore and fiber of the paper, and every other bit of space between layers of paper and between copper strands, as well as all other unavoidable minute voids, with compound.

The application of the lead sheath is the last step in the manufacturing process. The cable is taken directly from the impregnating tanks to the "lead press." It is important that the oil should not be allowed to drain out at this stage.

The lead press, although a machine of great power operated by hydraulic pressure, is not at all complicated. Pigs of lead are placed in a tank to one side of the press where they are melted but not heated more than enough to allow the lead to flow into a large cylinder where it cools down to a plastic state. Just below the cylinder, as shown above, is a sort of chamber into the back of which the cable enters through a closely fitting gland and out of which it emerges in

(*Continued on page 367*)

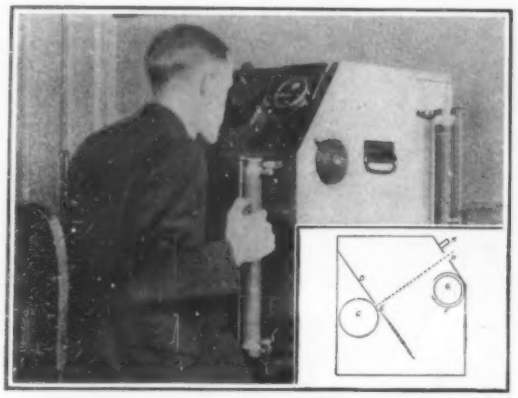
For Faster Seeing

Tests that Show How Better Lighting Makes Us See Faster as Well as Better

By M. Luckiesh

Director, Nela Park Laboratory of Applied Science

SEEING an object involves time, intensity of light, character of lighting and many other factors. Therefore, in our industrious lives where *seeing* is linked with *doing* the question of light is very important. It was long ago recognized that improper lighting lowered production, increased spoilage, and decreased safety but not much consideration has been given to the influence of intensity of light. That this is a factor is easily determined but how much of a factor is a matter for careful and tedious research. Everyone has had the experience of reading when twilight was falling. A careful observer would have noted that it became necessary to hold the printed page closer to the eyes as the intensity of light diminished and that the reading became *slower and less certain*. But this condition obtains at very low intensities. Nevertheless other factors, such as the ever-present time element in seeing, suggest the possibility that even at higher levels, intensity of illumination plays a part in any act depending upon vision. Furthermore, light is enlivening and perhaps we may react more quickly under higher intensities than under lower illuminations.



C is a drum containing the printed matter, which passes under the aperture *E*. *D* is a white or gray screen; *G* an opal glass cylinder containing a lamp; *F* a screen. The light can be varied as desired. The head rests at *K* and the eyes see the printed matter at *H*

The apparatus for the speed-of-reading test, shown diagrammatically and in use

In order to convince ourselves that intensity of illumination plays a prominent part in what may be termed the speed of seeing it is only necessary to provide a moving test-object containing various sizes of type and change the intensity of illumination. C. H. Stickney devised a striking experiment shown in the lower picture. The drum, containing letters of various sizes, is placed on the turn-table of a modern phonograph. When it is illuminated to a low intensity we can see only the larger letters at a certain speed but on suddenly illuminating it to a much higher intensity the ease of recognizing the smaller letters and even the large ones is very apparent. This strikingly illustrates the influence of intensity of illumination on the speed of vision but gives little idea of the magnitude of the effect.

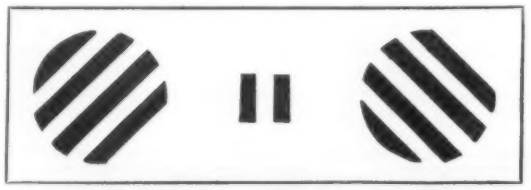
In order to determine the magnitude a number of investigations were begun in Nela Research Laboratories. The writer and his colleagues chose first the very common process of reading. After considerable experimentation an Old English type was chosen as best suited for the purpose. Owing to its complicated letters and to a lack of familiarity with such type, the reader must scan all words more carefully than in the case of common type. This is a desirable feature. A belt of this printed matter was driven by a carefully governed mechanism (upper photograph and drawing) having a direct-reading speedometer attached. The printed matter passed underneath a slit wide enough so that several lines were visible. The observer controlled the speed of the mechanism so that he could have the lines of reading matter pass at the maximum speed for which he could read aloud accurately. The intensity of illumination could be varied within wide limits.

The result of tests on many observers show conclusively that reading can be done faster and faster as the intensity of illumination is increased. There is evidence that the speed of reading continues to increase as the intensity of illumination is increased far beyond any intensities of artificial light now in use. The results for reading black print on both white paper (reflection factor 80 per cent) and gray paper (reflection-factor 22 per cent) are as follow:

Illumination in foot-candles...	2	4	8	16	24
Relative speed of reading; black print on					
white paper	100	111	121	128	131
gray paper	100	125	160	188	204

The black print on white paper represents usual reading matter; however, much of our seeing is a matter of distinguishing lesser contrasts, hence the test involving black print on gray paper. Here the increase is very marked.

Dr. P. W. Cobb is conducting investigations designed to be more analytical. Up to the present time he has used parallel black and white lines as a test-object, as illustrated. In some of his experiments he has introduced confusion patterns respectively before and after the presentation of the test-object. These investigations are too complicated for a detailed account here. Dr. Cobb found an increase in speed of recognition as the intensity of illumination was increased from one to 100 foot-candles with no indication that the increase would not continue for even higher levels of illumination. When the illumination intensity was increased from 5 to 20 foot-candles, for example, the speed of recognition of the test-object appearing out of a clear field increased over 100 per cent. Over the same range the speed was increased about 75 per cent when the test-object was preceded and followed by

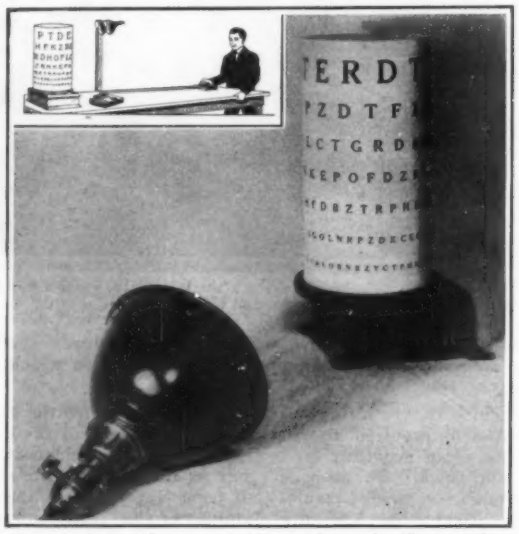


These three patterns were presented in the order indicated, the first one remaining on the screen three times as long as the second, while the third was left on at the end of the test. The purpose is to measure the interval necessary for recognition of the presence of the intermediate object. It is found that this interval is longer when the "confusion pre-exposure and post-exposure" objects are used with it, than when it is used alone

Another test for quickness of seeing

confusion patterns. The latter case approximates the condition of a continuous visual process such as reading. Such work as Dr. Cobb is doing may eventually make it possible to appraise the increase in production likely to result from a proposed lighting installation.

Now let us consider tests in factories. D. P. Hess and Ward Harrison have just reported an investigation in the inspection department of a well-known factory. They found an increase of 12 per cent in the production (number of pieces inspected of 44 workers) as the illumination intensity was increased from 5 to 20 foot-candles. The increased cost of lighting was equivalent to only 2.5 per cent of the payroll of the workers involved so that there was a gain in production of approximately 10 per cent without additional cost. W. A. Durgin a few years ago reported various increases in different departments of a number of factories. In his cases usually the system of lighting was greatly improved at the same time that the intensity of illumination was increased. His increases in production varied from 8 to 100 per cent depending upon the nature of the work and the change in character and intensity of illumination. Recently a large factory reported an increase of 10 per cent in production in the daytime resulting from cleaning the windows.



Apparatus, and manner of use, in a simple test for showing the influence of light intensity upon the speed of vision

In all cases the cost of better lighting is such a small part of the value of the increased production that the better lighting appears to be eminently worth while economically.

Furthermore, these higher intensities and better lighting make work-places safer and more cheerful. Much work remains to be done in order to establish accurate figures of the economics of better lighting in various activities but the data already available indicate that the entire lighting bill of this country would be more than paid for by the increase in production in the industries. In other words, if factories were lighted to higher standards the entire lighting of this country could be accomplished at a net cost of less than nothing.

Ammonia from the Air

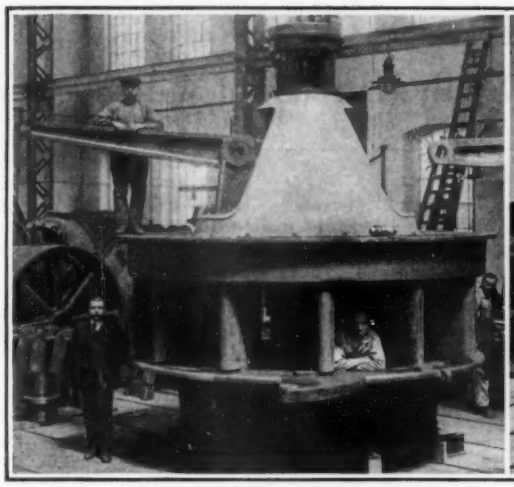
IN 1899 Sir William Crookes pointed out that the world's food supplies are dependent upon a supply of nitrogenous fertilizers to the soil. Each crop takes so much out of the soil that unless this essential material is replaced the yield per acre steadily drops. There is an inexhaustible store of nitrogen in the air, but nitrogen as such is one of the most inert of materials. It is only when it has been made to combine with other elements, such, for example, as hydrogen, that it becomes available as plant food. The problem in this case consists in taking from the two abundant sources, air and water, the constituent nitrogen and hydrogen and combining them in the form of a new substance, ammonia.

At the beginning of the present century there was no known method for any such fixation of nitrogen, but as the result of applying pure research there are already many industrial methods of fixing nitrogen in actual operation on a very large scale. This great result has been achieved in the important instance of the synthesis of ammonia.

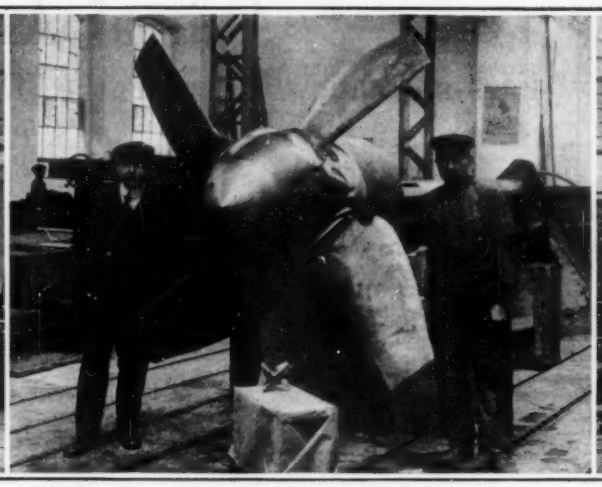
Thermodynamics supplies two of the most fundamental laws of science. The first law is that we can not get perpetual motion, we can not get work for nothing. The second law is that all spontaneous proceeds (and these only) may be utilized to give work.

On applying these laws to chemical reactions Willard Gibbs, followed by van't Hoff and others, obtained a mathematical relationship called the Mass Law. This law revealed the fact that it was within the power of the chemist to make the reaction $3H_2$ plus $N_2 = 2NH_3$ go in whichever direction desired, since the effects of changes in such factors as pressure and temperature could be predicted. The first problem was to find the most suitable equilibrium. This was done when it was found that the production of ammonia is increased by the application of 200 or even 1000 atmospheres' pressure. The next problem to be solved was the regulation of the temperature to give the most satisfactory yield. The ammonia must be produced at a practical rate and to bring this about substances termed "catalyzers" are employed to hasten the reaction and in addition materials called "promoters" have been discovered which increase the catalytic efficiency.

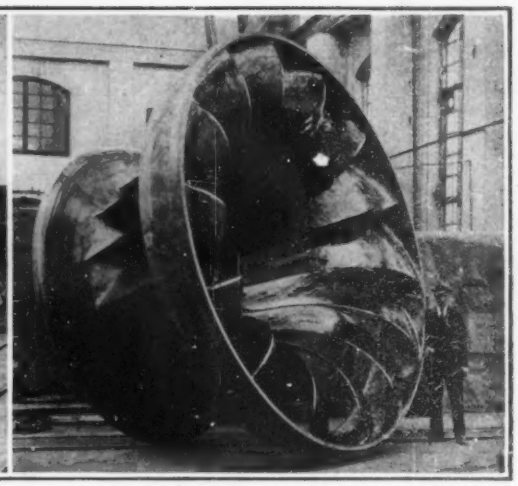
By applying all these principles the Germans have already succeeded in producing ammonia at the rate of over 1000 tons a day. Thus, from the knowledge obtained by pure theoretical and laboratory research, there has been achieved a result which is vital to the existence of the white population of the world.—*Abstract from address by Professor J. W. McBain.*



The casing of a Kaplan turbine, showing the extreme simplicity of the guide vanes



The rotor of a Kaplan machine of 1000 horsepower, and the tiny experimental model (below)



A modern Francis turbine, showing the extreme weight of this part of the machine

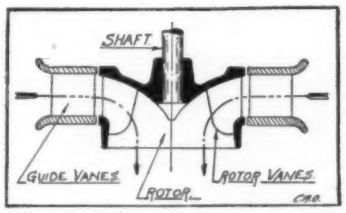
New water turbine designed by Prof. Kaplan of Czecho-Slovakia, showing how it contrasts in fundamental structure with the existing standards

Speeding Up the Water Turbine

By C. A. Oldroyd

MORE power—more speed—at less cost: along these lines in one way or another, all modern power generators have been developed.

The slow steam engine gave way to the high-speed steam turbine of immense power; the huge water-wheel was superseded by the Francis turbine, and here development seemed to stop. With the steam turbine the high-speed dynamo was introduced; and engineers longed for a water turbine of corresponding speed.



Section through a Francis turbine

After lengthy research, Prof. Kaplan, of Brunn University, Czecho-Slovakia, has now succeeded in designing a high-speed water turbine, a machine of extreme simplicity.

In the Francis turbine, the water enters the rotor through a set of guide vanes surrounding the rotor; in passing through the latter, the water transmits its energy to the rotor. Such turbines have very large and correspondingly heavy moving parts; weighing many tons.

In the Kaplan turbine, the guide vanes lie at right angles to the rotor blades. The heavy rotor is here reduced to a kind of ship's propeller, having either two or four blades.

Through such a turbine, the water can pass at very high speed, so that the diameter of the rotor can be reduced to one-half that of a similar Francis turbine. Chunks of ice, timber fragments, etc., which might wreck a Francis turbine, can easily pass through a Kaplan turbine.

As a general rule, the Kaplan turbine rotates four times as fast as a Francis turbine under similar conditions, so that the high-speed dynamo can be directly coupled to the rotor, and belt and gear transmissions are done away with.

From the photograph showing the casing and guide vanes for a 1000-horsepower turbine, their extreme simplicity is evident. The Kaplan turbine has a further advantage, it shows no falling off in efficiency when running at less than full power. The rotor blades are adjustable, their inclination can be varied according to the load. The inclination is controlled by the large lever shown above the casing.

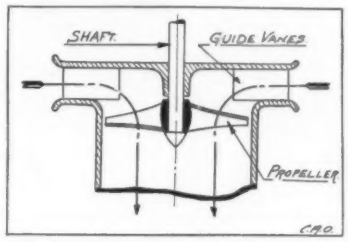
The old "umbrella" type of dynamo driven by a Francis turbine impressed the laymen very much, but gave anxious hours to the station engineers. Now it will be superseded by fast turbines of the Kaplan type, with lightly loaded bearings and compact rotors. Standard high-speed dynamos, as used with steam turbines, will be employed, and in general appearance, such a plant will greatly resemble a steam turbine installation.

A Movie "Mayflower" of Steel

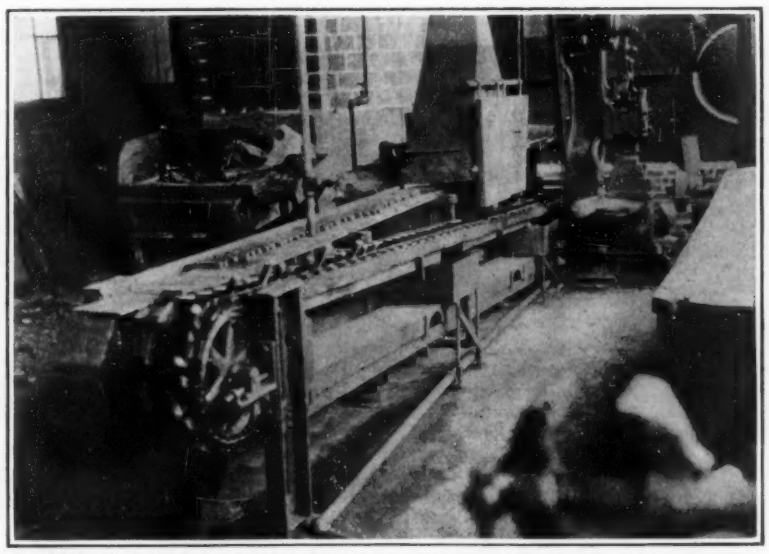
A REPRODUCTION of the "Mayflower" has been set up in Charles Ray studios in Hollywood, California, and was used in the filming of "The Courtship of Miles Standish." This vessel is as nearly an exact copy of the original as the builders could make it, except in one important respect. The hull was entirely of steel. Her length was 102 feet, her ample beam was 24 feet, and her molded depth was 14 feet. The copied hull was mounted by means of a ball-and-socket joint on the top of a heavy concrete column, in such a manner that the director of the film could have it rolled in any way he desired. This work was performed by steam generated by two 25-horsepower boilers, and whether it was necessary to produce a gentle ground swell, a heavy beating-to-windward pitch, or a hurricane, or even to throw the "Mayflower" on her beam ends, the result was accomplished the instant the director megaphoned the signal.

To carry the illusion further, a wall and bed of concrete large enough to hold an acre of water was constructed. This miniature sea, when agitated, gave a very realistic representation of the Atlantic Ocean. The imitation was assisted by many sorts of ingenious water towers or "breakaways" by means of which hundreds of tons of water was hurled against the sides and over the decks of the little Pilgrim ship, quite after the fashion in which the ocean must have handled her prototype in 1620.

If the shades of John Alden and Miles Standish were hovering about, we wonder what would have been their perplexed opinion of the performance!



Section through a Kaplan turbine



The left-hand platform carries the dull tools into the furnace; the other, consisting of a series of small water-filled buckets, brings them back to the operator after a session with the hammering and grinding machines in the right background

The chisel-sharpening machine that keeps a big granite-cutting shop supplied with keen-edged tools

Sharpening a Thousand Chisels a Day

By Francis A. Westbrook

IN those mills known as "granite cutting plants," where blocks of granite are brought in from the quarries to be made suitable for building and monumental purposes it is necessary to use a great many small cutting tools, which require frequent sharpening to insure a good quality of workmanship and efficient production.

In a large cutting plant it is necessary to sharpen something like 1000 of these tools every day, so that unless proper means are employed to keep down the cost this might very easily be a serious item of overhead expense. Very effective means have, however, been found in the adoption of the sharpening machine associated with the power hammer and carborundum wheel, as shown in the accompanying illustration. The arrangement is simply an adaptation of the moving platform idea with the other machines located with a view to maximum efficiency.

The sharpening machine consists of an oil-burning furnace and two small moving platforms—one to carry the dull tools into the furnace and one to bring those which have been sharpened back again. The oil furnace, operated by compressed air under 95 pounds pressure, power hammer, and carborundum wheel are shown in the background of the picture. The left hand moving platform, or chain, which is flat, carries the tools into the furnace where they are heated. A man sitting in front of the power hammer with his back toward the observer of the picture and with the carborundum wheel at his right hand, takes the tools out of the furnace, hammers them into shape, grinds them while still hot, and then drops them back upon the right hand chain.

This chain consists of a series of buckets which are at first filled with brine to temper the chisels when they are dropped in hot. As the chain moves along and away from the operator the brine flows out and cool water flows in, so that by the time they have reached the end of the chain, in the foreground, they are cool. The chain then drops them into a receptacle standing on the floor, which carries them back into service.

Where Water Pumps Itself

AN Oregon mine, well up in the mountains, has taken advantage of its location to pump the water out of its galleries, though its mean depth is about 600 feet, without any cost save that of installation. The water literally pumps itself. The secret lies in the fact that the mine location is such as to make possible the construction of a power flume, carrying the water off into one of the nearby valleys, and giving a 1500-foot head. Once the thing is started, it runs on indefinitely, the power from the flume being ample to run the mine pump.

Animal Animosities

Fact and Fancy Regarding the "Deadly Hatreds" of Wild Species

By S. F. Aaron

Drawings by the Author

The boldest of all birds attacking a red-shouldered buzzard, when the latter sought a roosting place uncomfortably close to the nest of the former

The standing feud between the screech owl and the larger hawks

THE nature writers, some of them unfortunately fakers, have derived much sensation from the imagined inclination of wild animals to engage in deadly struggles. Most readers enjoy a fight, in the telling and especially so if the moral responsibility for the lack of humanity happens to be wanting.

Pitched battles for the mere sake of fighting, or long continued contests for any cause are rare, or may never occur among the highly organized creatures. Despite the continual struggle for existence between those that prey or are preyed upon and the rivalries during the mating seasons the inhabitants of the wilds are generally prone to avoid hostilities that can gain them nothing but wounds. Most creatures fully comprehend their own powers and those of others capable of inflicting injury and they are unwilling to risk possible hurt or even engage in violent effort to little purpose. Thus the puma and the bears, though undoubtedly possessing a hatred for each other due to their seeking similar game, hold a truce rarely if ever broken, the stories to the contrary being pure invention. The bobcat and the Canada lynx, in those regions where their habitats merge, fully respect each other, even when one is hungry and the other has made a kill; and that these most grouchy carnivora, avoiding their own kind except during the breeding urge and at odds with all other creatures, keep from personal encounters is sufficient evidence of a common inclination.

The flies generally begin these fights, vainly trying to pierce the beetle's chitinous coat of mail; then the beetle seizes the marauder's leg, and the latter usually escapes only by sacrificing that member

Robber fly and tiger beetle

The fighting of males over mistresses of a common choice is a usual thing among the mammals and birds, but these are individual affairs upon the spur of the moment and they rarely mean more than a brief scrap, one contestant either quickly getting the worst of it, or the two backing off with mutual respect and each going its way. However powerful and possibly bloodthirsty the opponents, they are commonly too sensitive to injury and pain to continue receiving it. This is also the case among domestic animals, except when they have been especially bred to overcome fear and hurt, as the bull-dog and the game-cock.

With some species, as the flocking migratory birds, these rivalries are forgotten and the former scrappers mix amicably with each other. Among the polygamous, continually breeding species of warm countries or that originated there, as the domestic fowl and the peacock, these rivalries continue and thus also with the herding mammals where the weaker males are perpetually driven off by those stronger.

Feuds between different species, one or both of which threaten the safety of the other's young, are not uncommon and this is the chief cause of such hatreds as exist between the wildcat and the wolf, the mink and the fox, the raccoon and the weasels. The enmity that the crow displays toward the hawks is an example and it is shown also by the suspicion with which all herbivora regard members of the larger felines and canines. The deer and the hog have a similar but probably a less purposeful enmity for all snakes. The well-known animosity of the kingbird toward nearly all birds which it must regard as potential egg stealers, the similar warfare declared by the purple martin against hawks and crows, the battles between robins and thieving grackles and the suspicions directed toward the jay by all small birds are merely developments of self-preservation.

The feud between the sparrow falcon and its much larger relatives the red-tailed and red-shouldered buzzards is not so easily comprehended, for the big hawks cannot readily reach the young falcons in the narrow tree cavities and where the nest is always guarded; it may be mere suspicion and the knowledge on the little falcon's part that the buzzards might enjoy fat young falcon. The animosity shown is, nevertheless, out of proportion to its cause; the falcon, giving evidence of a wing power equal to that of any bird of its size, swoops from far above upon the back of its enemy, sometimes striking and tearing the feathers away, but rarely if ever disabling the larger bird so that its retreat is checked.

Among the reptiles certain feuds exist that are more difficult to explain; such is the king snake's desire to destroy all poisonous and some non-venomous species larger and seemingly more powerful than itself. Nor is it understood why the rattlesnake shows a readiness to inflict its horribly aggressive defense upon dogs, cats, larger birds and humans and regards with indifference the nearness of horses and cattle, unless trodden upon. Its enmity for the hog is natural enough. It may seem strange also, considering the small intelligence with which we credit reptiles in general, that the skunk and some snakes readily distinguish herbivorous from carnivorous animals, fleeing from the latter and approaching deer and cattle to feed upon the flies that they attract.

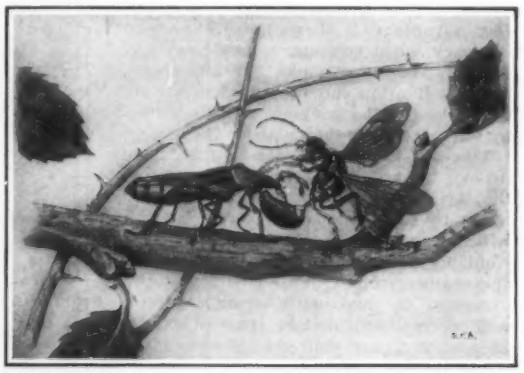
It is among the insects and their allies that specific animosities are most bitterly expressed, though many of the more highly developed six-legged banditti know their peers and decline to mix with them in the struggle for existence. Others exceed the mammals in daring and pluck. The social hymenoptera with their stings as weapons for the defense of the colony habitations are examples of the highest development in the expression of that which may be called nothing less than patriotism. The animosities these valiant little creatures show toward any enemy that may encroach upon the paper nest or the hive are endless. It may appear strange that the solitary bees and wasps do not show this same spirit generally in defense of their nests, but this is explained by the fact that the larger creatures give the diggers and mud daubers little concern and it may be assumed that the encroachment of moles or shrews or earth-boring beetles would be resented. A digger wasp that only preys upon spiders has been seen to attack and drive away a large grasshopper from the vicinity of the burrow.

Whether fighting in defense of the nest or because of the desire for food the arthropods present the most daring and valiant warriors and the battles that result are the most prolonged and vigorous. Often the size and prowess of the attacked cut no figure in the determination of the attackers. Thus the robber-flies, the assassin bugs, the tiger beetles and certain spiders eagerly seize upon creatures far larger and more powerful than themselves and those also capable of inflicting injury or death. The wheel-back bug, the cone-nose and the flat stink-bug, or any one of their assassinating relatives, commonly attack whatever may come within reach of their deliberate, but no less sure grasp and the puncturing power of their sword-like probosces. The intended victim may be endowed with sting or severing jaws, but the assassins do not hesitate and occasionally a yellow-jacket or a polistes wasp may be seen with its vitals pierced, effectively applying its sting to the bug, one dying of enforced anaemia, the other of injected venom.

Swifter of wing than most predacious hexapods, the robber-fly represents among insects the position of the hawk among birds; its attacks are often made in mid-air. It does not hesitate to pounce upon wasps or bees, generally seizing the victim from behind with its long, strong legs and in such a manner that it cannot be reached by the sting. Occasionally it risks too much, as when attacking the digger wasps; the extended and flexible abdominal petiole permits the sting to pierce the fly. The big, black robber-fly also sometimes clashes with the queen of hornets, the beautiful big sand-hill digger and there is either an instant separation of the contestants, or the robber drops lifeless to the ground before its stiletto-like proboscis can stab its opponent. In such cases, however, all the animosity is on the part of the robber-fly.

Tiger beetles also are willing fighters, often when they do not seem to gain food thereby, though this may result from error in picking the victim, which may make a victim of them. The Cicindela does not hesitate to come to grips with an assassin bug, the awful odor of the latter, which effectively warns away the vertebrate insectivora, having no terrors for the beetle. This is an affair that any lover of a good scrap will delight to witness: crushing jaws and a coat of mail against a piercing sword and if there is not too much difference in size and strength the more agile and better protected beetle always wins by pinching off the proboscis, or the entire head of its adversary and then feeding upon it. In like manner the tiger beetle's armor serves a needed purpose when it attacks or is attacked by a robber-fly and this occurs not unfrequently. The beetle can seize only a leg of the fly and the robber cannot thrust its dagger into the beetle, but both are exceedingly persisent, rolling over and over in the effort to gain the fight, the robber's wings keeping it generally on top and eventually aiding it to get away, though often with the loss of a leg.

A very certain animosity of long standing is evident by the contests between colonies of ants; notably the big blacks and the equally large red and brown species, both common in our woodlands and fields. This is war with mob-like management, no drill nor generalship exhibited, but none the less a combination of actions and a determination that is worthy of patriotic emulation on the part of humans. For defeat only comes by total annihilation. Let the two colonies of these ancient feudists but chance to be established within ranging distance of each other and war is certain, one tribe as though at a signal making an onslaught upon the other, perhaps coveting its stores of food, but it may be there exists an ancient hereditary enmity.

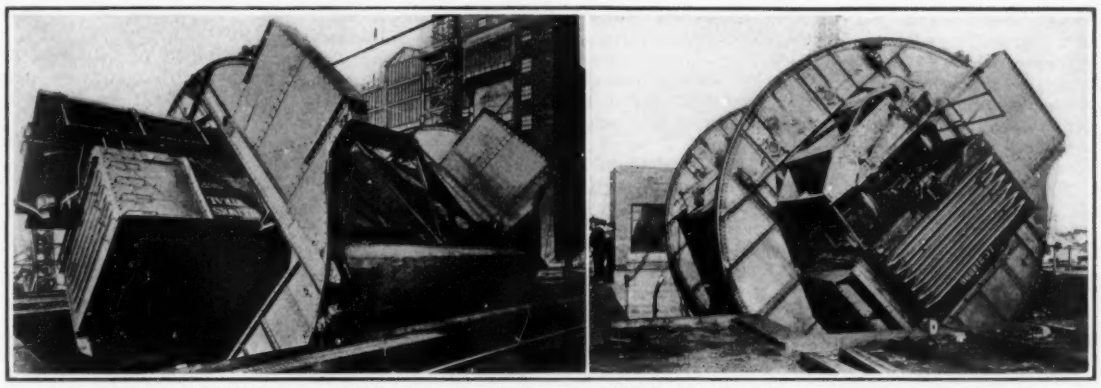


The bug is the aggressor; but occasionally it bites off more than it can chew. Against the wasp the assassin is very likely to perish by poison; though sometimes he is able to hang on and take out enough of the wasp's internal organs to produce mutual death

Assassin bug vs. mud-dauber wasp

Rotary Car-Dumping on a Giant Scale

DUMPING a fifty-ton car of coal in 1 minute 10 seconds, with only one man, unskilled, and a 35-horsepower motor—that is the feat being performed daily by a recent installation at St. Louis. With only the first unit of the Cahokia power plant completed at the present time the coal consumption averages but eight cars a day. Under the burden of eight cars a day the continued operation of the dumper seldom exceeds twenty minutes. The completion of additional units will, of course, place a greater burden upon the dumper, but it is interesting to know that with this minimum load, the contractors feel the dumper pays for itself in time and labor saved. They contrast the rotary dump method with the bottom-dump method, which usually requires the labor of two men for thirty minutes to unload one complete car of coal.



Two views of the gigantic jaws of the rotary car-dump at Cahokia (St. Louis) power plant. Twenty minutes' operation of the dump takes care of a day's fuel—and in this brief interval the big machine more than pays for itself

From the mechanical standpoint, the mechanism, as is the case with any rotary type of car dumper, has three distinct functions to perform, viz.: the rotation of the car through an angle which will permit the discharge of the material; support of the car on its tipping side; and the clamping of the car at the top. In spite of this multiple and seemingly complicated action, the operator, in this case, has but one controller handle to operate. This controller is of the drum type, similar in design to a street-car controller. And while it provides speed control its primary function is the starting of the rotating motor. All other operations are cared for automatically by limit switches.

With the car in the normal position on the dumper the controller handle is in the neutral position. To begin the cycle of operations, the operator moves the controller handle into the extreme forward position. Rotation of dumper and movement of the transfer table start immediately. Upon rotating ten degrees, a projection (built on the side of one of the roller rings) operates a track limit switch, which in turn, starts the top-clamp motor. This motor pulls the four top-clamps downward simultaneously, until all four clamps have become firmly seated upon the top of the car and have exerted a predetermined pull on the operating cables. When this predetermined pull has been reached it displaces an idler, operating a load switch, cutting off the motor and setting a high torque brake.

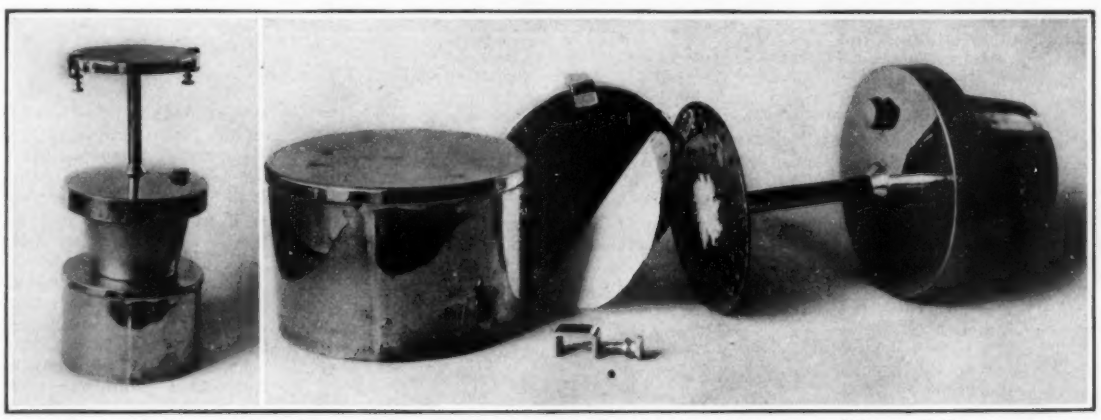
With the car then firmly held to its dumping side and clamped at the top, the dumper continues to rotate until the rotating motor is automatically stopped by limit switches at the end of the rotating movement. Up to this time all the operator has done is to move his controller handle from the neutral to forward position.

He now moves his controller handle through the neutral position and into the extreme reverse position. This reverses the direction of the rotating motor and the dumper returns to its normal position. On the return, when the dumper is within approximately ten degrees of its initial position, the top-clamp motor limit-switch is tripped, which automatically reverses the direction of this motor; and counterweights raise the top clamps to their initial position. When the top clamps have reached their uppermost position the clamping motor is cut out by a limit switch operated by one of the clamps. The rotating motor is also stopped on its return movement by a limit switch and the rails are held in correct alinement by a solenoid brake.

The outstanding feature of this car dumper is its fool-proof construction and its simplicity of operation. It is impossible for the operator to perform the cycle in any other than the correct way.

Determining the Fire Hazards in a Forest

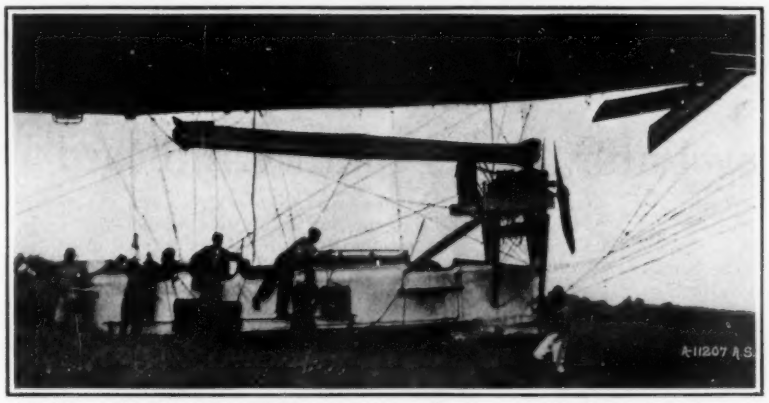
THE principle of the evaporimeter is applied in an interesting way in the inner-cell evaporimeter invented by Mr. C. G. Bates, Director of the Fremont Forest Experiment Station near Manitou, Colorado. In this special form of evaporimeter a round wick leads up from a reservoir holding about a pint of water and connects with a flat wick spread over a disk about 4½ inches in diameter. The flat wick represents the surface of a leaf. The disk on which the flat wick rests is perforated with a number of holes which may be considered to represent the stomata of a leaf. Evaporation can, therefore, take place on the under side of the wick. The metal cover above and in contact with the wick is blackened to absorb sunlight. The instrument is placed in an exposed position so that the wind can blow over it. The conditions of evaporation from vegetation are, therefore, approached very closely.



Assembled and disassembled views of the evaporimeter, which tells the moisture conditions of the forest trees and their susceptibility of the moment to fire

It has been determined that when water evaporates from the evaporimeter which we have just described at the rate of twenty grams in twenty-four hours, the conditions for forest fires are approaching the danger line. This is a tentative standard, subject to correction as further data are accumulated. Other conditions are taken account of in determining fire hazard such as the green or dry character of grass and weeds, the number of conifers in the forests and so forth. In October the hazard is greater than in June with the same rate of evaporation. It sometimes happens that the evaporimeter absorbs a slight amount of moisture and actually becomes heavier. At such a time there is no danger of fire.

The particular evaporimeter in use at the Fremont Forest Experiment Station is the standard with which others used elsewhere are compared. Others are made as nearly like this one as possible and calibrated. The calibrating is done by placing the standard evaporimeter and those under test on a table which is exposed to the sunlight and rotated slowly and at a uniform rate by a water motor, so that the conditions are exactly the same for all the instruments. Each evaporimeter is carefully weighed at the beginning and at the end of the test and the rate of evaporation compared. In making the comparison the ratio is carried to the third decimal place.



Airship equipped with condenser for recovering water from the exhaust gases and thus compensating for the weight of the fuel burned

Recovering the Weight from Burnt Fuel

TO maintain the equilibrium of an airship inflated with either helium or hydrogen gas, it is necessary at times to "valve" or, in other words, permit some of the gas to escape in order to compensate for the weight of fuel consumed by the engines, or to overcome the expansion of the gas caused by the heat of the sun's rays.

How to compensate for the weight of fuel lost and also to maintain the lifting gas at an even temperature so as to conserve the costly helium, which in the future is destined to supplant the dangerous hydrogen gas in lighter-than-air craft, presented a difficult problem for Government engineers. Although the experiments were financed and sponsored by the Air Service, credit should be given to Bureau of Standard scientists for developing a really successful device.

The condenser consists of a series of long slender pipes or tubes, .022 inches in wall thickness and one inch in diameter, comprising some 300 feet, through the inside of which gas is conducted on its way from the exhaust manifolds of the engine to the atmosphere. The air, sweeping over the outside of the pipes as the airship is in motion, cools the gases and the condensed water vapor is drawn off from a separator through appropriately located drains. The efficiency of the device is such as to produce enough water to weigh approximately the same as the fuel consumed.

The apparatus, which of necessity had to be built as light as possible in order to permit its use on airships, weighs only about 450 pounds, complete, is made of aluminum and aluminum alloys, and is sufficient to take care of the exhaust from two 150-horsepower engines. The efficiency of the apparatus was evidenced by the recent successful trial flights of the Army Airship D-3 at Langley Field, Va., and the Aberdeen Proving Grounds, Md., and it is quite likely that same will be installed eventually on all service airships.

A Scheme to Salvage Lost Ideas

THE progress of ideas depends much upon cross-fertilization. Many ideas never bear adequate fruit because they are held back by present standards of scholarly presentation. We need a more informal and unverified presentation of suggestive ideas, in order to speed up the fertilization process. Some scientific journals already approach the idea here suggested but do not, it is thought, officially recognize it.

Among thinkers are those whose minds pursue a thought straight to its conclusion, with no difficulty in concentration, and perhaps with some difficulty in supplying illustrative and corroborative material. Opposed to these is the man whose mind strikes a subject like a dum-dum bullet. A dum-dum spreads out at once. It tears a big hole, but it doesn't get very far. The dum-dum mind finds difficulty in finishing what it starts, because the impact starts associations laterally in all directions instead of straight ahead. It is distracted by the push and pull from all sides, and perhaps has an unconscious resistance against going ahead. Its results are apt to be bulky but fragmentary, uncorrelated, not clean cut; in extreme cases, incoherent and ineffective.

The dum-dum mind is less likely to produce completed achievements of accepted merit. The "armor piercing" mind, however, would frequently fail to get its initial impetus and direction if it were not for some explosive, variant idea, originating in this or another mind. Very often such a stimulus comes from the combination of two widely different and previously separated elements. It is among such elements that the dum-dum mind is at home. If it be not fetching the metaphor too far, the dum-dum mind is then also like the explosive bullet or the secondary charge in the projectiles which reached Paris from the supergun; it sets in motion new forces, new lines of thought, by combining old elements.

To adopt a less crude metaphor; is it not true that many minds secrete valuable ideas faster than they can possibly be worked out in the form which standards of scholarship demand for reputation? Are not such ideas largely lost, like the spores of mushrooms or the myriad spermatozoa? The minds that give them birth are in many cases communicative but shy or isolated. Where they have been willing to give their excursive speculations to the world they have been greatly appreciated even tho greatly criticized. Such, in widely differing ways, were Nietzsche, Pascal, Amiel, Aurelius. Such a contribution, in a sense, is Jung's "Psychology of the Unconscious."

Even where there is some interchange of ideas between scientists of a given field, there is comparatively little cross-fertilization between academic departments. In lieu of compulsory continuation courses for all instructors, or super-seminars, there should at least be informal interdepartmental discussion groups in every college faculty.

May it not be possible to find some common channels through which valuable associations of ideas—flashes and glints which may or may not stand the assay of verification—may be put into currency and made permanently available? This idea is itself an unverified inspiration, advanced for criticism, perhaps for experiment. It comes to us, in the first instance, from Prof. Thomas D. Eliot, of Northwestern University.

It is proposed that the scientific quarterlies introduce an exchange and discussion department whose editor would seek for and select from the best commentary material secreted from time to time by readers and associative thinkers.

Furthermore, reviews of other periodicals should include occasional excursions into widely different fields, and might well be included in the same department from time to time.

For such a department the name "Marginalia" is tentatively offered as suggesting the type of idea which a thoughtful reader jots down in his margins. Contributions might be limited in length to one paragraph; might be limited in each issue to one general field but the subjects announced some months in advance; might be made anonymously when desired, in order that no question of scholarship might inhibit the exchange of ideas.

Tests of Natural and Culture Pearls

A SIMPLE optical method of distinguishing the Japanese "culture" pearls from wholly natural pearls is described by Dr. F. E. Wright in the Journal of the Washington Academy of Sciences, 1923, vol. 13, p. 282. In a bead of mother-of-pearl, such as is always used for the nucleus of the "culture" pearls, the nacreous layers are not concentric to the surface, but are approximately plane, being parallel to the surface of the shell from which the bead was cut. Now normal to this surface the reflecting power, and consequently also the opacity, is at a maximum; whilst at 90 degrees from this direction (that is, looking along the laminæ) there is a minimum of reflection and of opacity. A "culture" pearl when viewed in a strong reflected light (for example, with the observer's back to the sun) shows at the opposite poles of one diameter a small bright spot due to the light reflected from the laminæ of the enclosed bead of mother-of-pearl. In a strong beam of transmitted light (arranged in a closed box with lens and mirror, the pearl resting in a circular aperture) the "culture" pearl shows two positions of maximum opacity, whilst the natural pearl is the same in all positions. A third method, which is applicable also to "culture" pearls containing a real pearl as nucleus, is given by an examination of the walls of the hole drilled through the pearl. The pearl is illuminated by a strong side light and a minute bead melted on the end of a gold wire is inserted in the bore to act as a reflector, which is viewed under the microscope. The behavior is then substantially as in the other tests.

Saving Pulley-Power With Cardboard Discs

SEVERAL years ago, in some experiments conducted with high rotational speeds, the attention of the Riverbank Laboratories of Geneva, Ill., was called to the relatively large amount of power required to maintain such speeds. As is well known, the head resistance of the air against a body moving through it is proportional to the square of the speed with which the body moves, and consequently the power required is proportional to the cube of the speed. This means that doubling the speed of a moving body quadruples the air resistance and calls for eight times the power. The importance of this fact is well recognized in aeronautics. The fact that airplane speeds have now been attained which are practically double the maximum attainable at the close of the war, and this with only a very slight increase of motive power, tells how successful aeronautic engineers have been in reducing the head resistance of aircraft.

This naturally suggests the question of power losses due to air resistance in flywheels and line shaft pulleys. Of course, anybody who stops to think for a moment realizes that a certain amount of power is wasted in stirring up the air about the revolving spokes of a machine pulley. While the conditions prevailing in the case of a body moving through the air may not hold in the case of a revolving wheel, yet the facts cited above indicate that power losses, due to air resistance, may be considerable. The two practical questions that arise are, first, how much power is thus wasted, and second, how can this waste be prevented by means that will not cost more than the saving effected. The answer to these questions has been found by actual measurements only within the last year.

One naturally thinks of trying the experiment of running a pulley in the air and in a vacuum and measuring the power required in the two cases. Such a procedure is direct and scientific, but it is a fussy experiment to perform, and offers no practicable means of eliminating the waste once its magnitude has been measured. Stream-lining the spokes of pulleys is also a possibility, but it is an open question how effective such a method would be in the actual case. The method finally employed will appear in the following description of the actual experiment performed at Riverbank Laboratories.

The power expended in producing a rotational motion is given by the well-known formula

$$\text{H.P.} = \frac{6.2832}{33000} \times \text{R.P.M.} \times \text{T.}$$

in which T is the torque on the driving shaft. The torque required to drive the pulley was measured by a simple, but very effective torque dynamometer, devised for the purpose. For the working out of the details of this instrument, credit is due Mr. B. E. Eisenhour of the Riverbank Laboratories. A standard ½ h.p. variable-speed motor was nicely mounted on trunnions so as to be free to turn about the armature shaft. The test pulley was mounted on an extension of this shaft. The reaction of the load on the motor case tends to turn this. The force required to balance this reaction was measured upon a sensitive spring balance. The product of this force by the length of the lever arm on which it was applied gives the value of T in the equation for computing the horsepower. The speed was measured with a stop watch and a tachometer applied to the shaft.

A wood pulley with a 6-inch face, 12 inches in diameter, with four flat spokes, each 4½ by ⅜ inches, and a rim 7/16 inch thick, was mounted on the shaft. At a speed of 1840 r.p.m., the force on the balance at the end of a 2½ inch lever arm was 3.375 pounds. The computed horsepower expended was .246, a very appreciable fraction of the load which such a pulley might be expected to carry.

Two cardboard discs were then fitted to the two sides of the pulley thus enclosing the spokes. Under these conditions, the force was reduced to .25 pounds, at a speed of 1850 r.p.m., and the horsepower to .018. The saving thus effected by the simple expedient of enclosing the revolving spokes was .228 horsepower. The process also materially increases the safety of such a pulley.

In the following table, the results of a number of similar tests on pulleys of various types run at different speeds are given. These tests were made by Mr. J. J. Gibbens, Engineer for the Calumet and Hecla Mine.

Type of Pulley	*Size*	*R.P.M.*	*Saving in H.P. with Discs.*
Steel, 6 arms	24″ x 2″	550	.00375
Split Wood	12″ x 4¾″	1760	.029
Split Wood	12″ x 6¼″	300	.0007
Split Wood	12″ x 6¼″	400	.00124
Split Wood	12″ x 6¼″	500	.00149
Split Wood	12″ x 6¼″	600	.00223
Split Wood	12″ x 6¼″	900	.00536
Split Wood	12″ x 6¼″	1000	.00756
Split Wood	12″ x 3″	1000	.00372

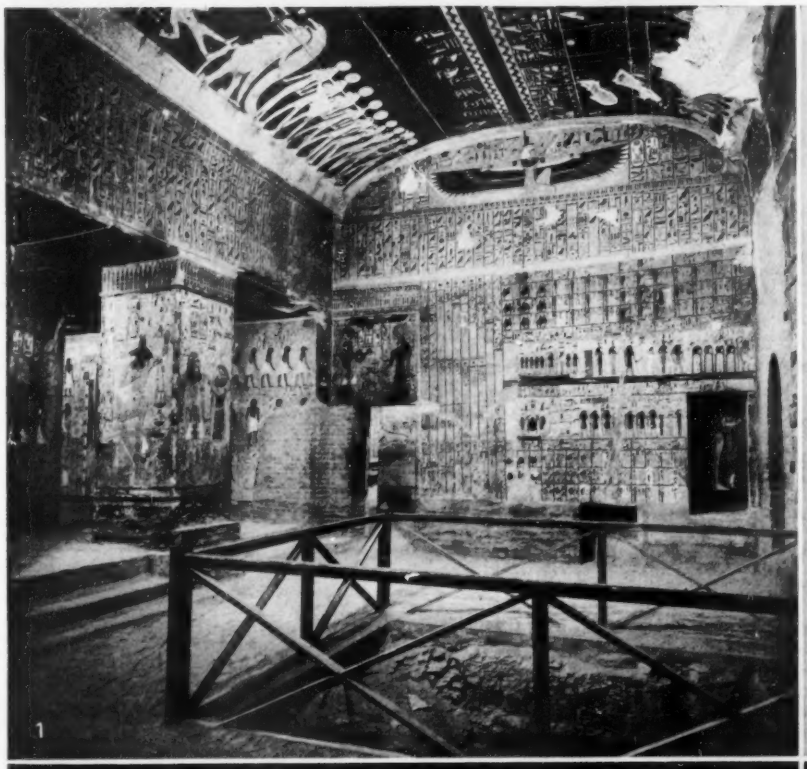
It is to be noted that the power loss increases rapidly with both the speed and the size of the pulley. At first glance, these losses seem negligibly small. However, the operator who cares to apply these figures to his own power costs, taking into account the number of pulleys in an entire plant that are wasting that power throughout the year's operations, will find that this wastage will represent the income from no inconsiderable investment. Thus the total cost at eight cents per horsepower hour of the power loss in the 24 inch steel pulley given above will amount to about a dollar a year. The simple plan suggested of converting the wind-throwing pulley into a revolving cylinder will result in a saving of considerably more than it costs.

The Use of Waste for Building Materials

IN a lecture delivered before the Royal Academy of Arts, London, on Wednesday, November 21, Professor A. P. Laurie discussed the manufacture of building materials from such waste materials as blast furnace slag, cinders, clinker, and, in the neighborhood of Edinburgh, burnt shale, the residue from the stills of the oil industry. There are three ways in which these materials can be utilized—for the production of bricks, for the production of cement, and as aggregate mixed with Portland cement or plaster of Paris. The general method adopted for the production of bricks is known as the sand lime process. Briefly, this process consists of mixing the aggregate with a certain proportion of lime and water, squeezing it into a brick under a pressure of some two hundred tons to the area of the brick and then steaming under high pressure or in open, steaming chambers. Bricks are now being manufactured by this process from sand, blast furnace slag, granulated by being run while hot into water, clinker, town refuse, slate dust, and burnt shale.

Cement is being manufactured by two Scottish steel companies from blast furnace slag granulated, mixed with lime, and then raised to a high temperature so as to form a clinker in the same way as ordinary Portland cement was manufactured. This cement, known in Germany as iron cement, can be sold in this condition, or can be finally ground with a mixture of a certain proportion of raw blast furnace slag.

The uses of these materials as an aggregate opens the question of how far it is possible to reduce the content of Portland cement, and at the same time, get sufficient strength for building purposes. The objection to the usual building slab made of cement is that, in order to be able to remove it from the machine as soon as made, the content of water has to be kept low and, consequently, the crushing strength of the finished slab is also low. Two interesting methods of getting over this difficulty are the Crozite method, in which the cement bricks were sliced off from the bottom of a column of cement and aggregate, and the method in which a heavy compression is put upon the bottom and top of the slab at the moment of completion. The Crozite process is being carried on in America.



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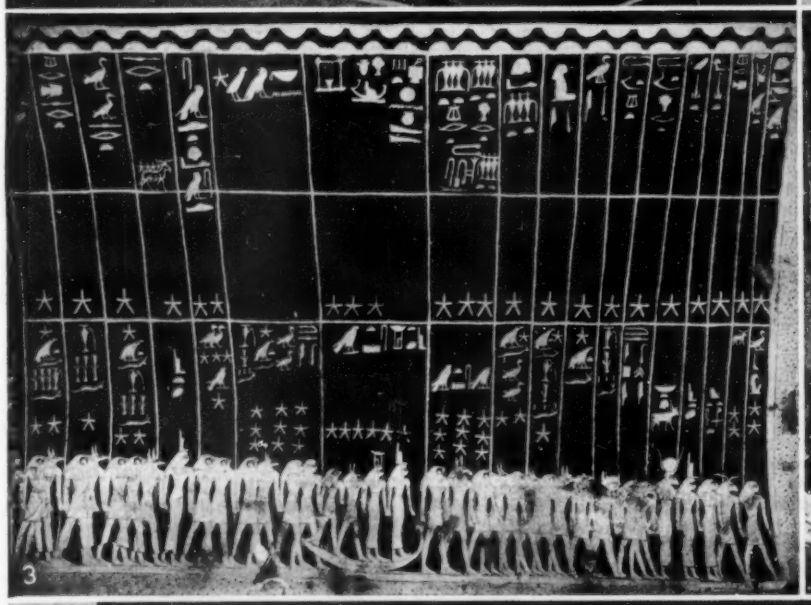

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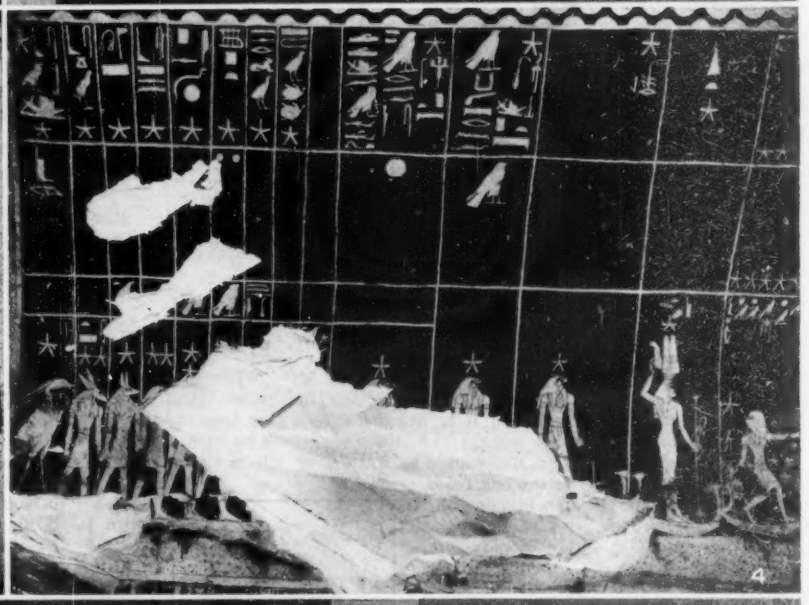

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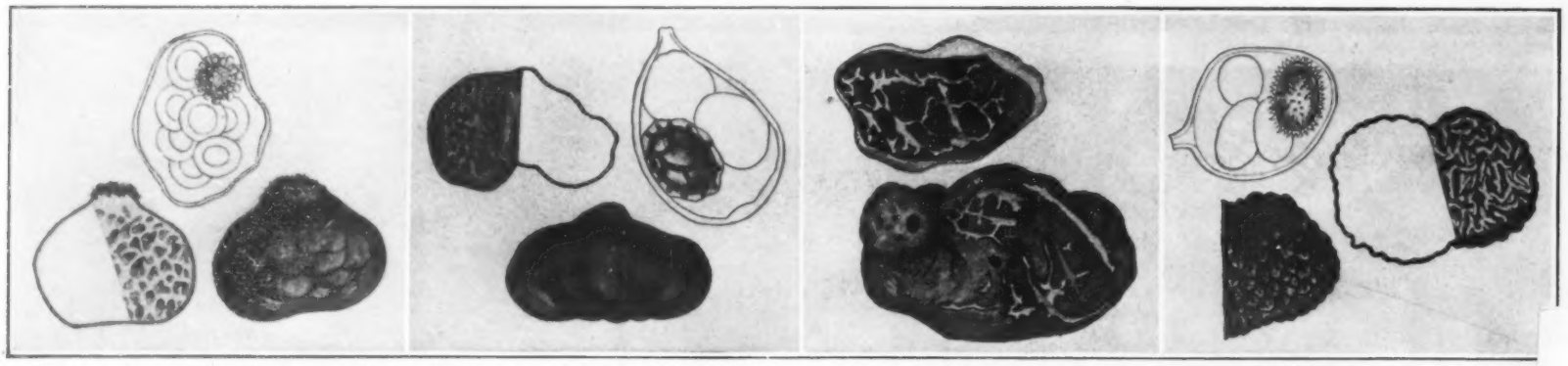
Photographs copyright by the Metropolitan Museum of Art

ONE of the most interesting finds outside the Tutankhamon Tomb, the most gorgeous and important Egyptian discovery is the tomb of King Seti I. (about 1313-1292 B. C.) of the XIX dynasty, in the famous Valley of the King's Tombs. The ceiling in the sepulchral chamber is adorned with a remarkable astronomical chart or list, which is now being studied by astronomers as well as archæologists. View 1 is the hall and views 3 and 4 show star lists. The tomb was excavated by the Metropolian Museum of Art. View 2 is a small Greek bronze horse which is given a place of high honor at the head of the great staircase at the Metropolitan Museum of Art. It is only about 16 inches high, but appears almost of heroic size; it weighs 25½ pounds. It dates from about 480-460 B. C. It is a masterpiece of Greek sculpture. Views 5 and 6 are Chinese tomb figures, the long group being girl musicians and the single figure is a dancer. The musicians are made of slightly fired soft pinkish clay and are hand painted and probably date from the eighth century of the Christian era. They may be regarded as sculpture rather than pottery; there is so much expression in the faces. These are relics of a time when the art of the West was at a standstill, and they speak volumes of the great vitality of the art of the East. All these figures are in the Metropolitan Museum of Art, to which we are indebted for the photograph.

THE LORE OF THE ARCHAEOLOGIST: FROM THE STAR MAPS OF AN EGYPTIAN TOMB TO CHINESE STATUETTES



Terfezia leonis, one of the Terfas so highly prized by the ancients

The "Italian truffle," *Tuber magnatum*, which sometimes weighs twelve pounds

The "white truffle," *Tuber album*, which usually projects out of the ground

The "Perigord truffle" or "French truffle," *Tuber melanosporum*

Four varieties of truffle, shown externally and in cross section; with, in three instances, a microscopic view of a single spore-sac with its contents

Truffles and Truffle Hunters

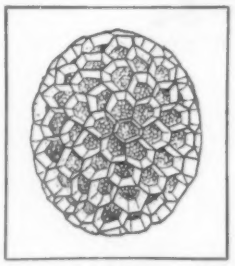
Some Details About One of Europe's Lesser Known Crops and Its Harvesting

By William Alphonso Murrill, Ph.D.
New York Botanical Garden

FEW native Americans know much about truffles because they never saw any—except perhaps in slices on an occasional dish of meat served in a restaurant; but many of our foreign-born population know them intimately, because they are abundant in Italy and France and occur in smaller quantities in northern Europe and England. The truffle gets its name from the Latin word *Tuber* and it occurs singly or in small clusters in the soil beneath certain kinds of trees. In shape, it is rounded or irregular, about the size of a walnut, and varies in color and markings according to the species, often being black and covered with coarse warts. The color of the interior also varies, but it is always solid like a potato and usually mottled with white veins. Its most important characteristic, by which it is detected and by reason of which it is valuable, is its decided aromatic odor. This odor is sometimes offensive when mature, freshly gathered truffles are brought into a room in quantity; but in the young stages or when cooked it is always agreeable, though sometimes rather weak.

Spore-sac and spores of *Tuber aestivum*, known in Europe as the "summer truffle" or "English truffle." It strongly resembles the "Perigord truffle" externally, but only so

When one hunts truffles in the woods in France or Italy, one goes first of all to the oak trees, and afterwards looks under beeches and hazel trees. They are also to be found under chestnut, birch, willow, poplar, elm, etc., but not to the same extent. An old saying in France is, "if you want truffles, plant acorns;" and this has been done on a large scale in many of the truffle districts with great success where the drainage is good and truffle-eating animals are excluded. It would not be effective outside of the truffle districts because there would be no spores or spawn present to start a crop, unless these were introduced in some form.



Spore of *Tuber canaliculatum*, a new truffle recently found growing in Michigan

The time required to produce a crop of truffles after planting oak trees varies with the soil and climate. Some truffles usually appear in five or six years, more in eight or ten, and a maximum harvest may be expected between fifteen and thirty-five years. The soil should be light, well-drained, shaded, free from stones, and contain a certain percentage of both lime and clay. Warm weather and copious rains are essential, especially in late summer. In dry seasons, truffles remain small and are liable to rot or be destroyed by insects. They are also ruined if the frost reaches them.

Most of the species are mature and ready for harvesting in the autumn or at any time during the early part of the winter when the ground is not frozen, the full season extending from August to March. They are found from a few inches to nearly a foot below the surface of the soil and are located by means of the strong aromatic odor which emanates from them. Squirrels, hogs, and other animals dig them up and devour them with the utmost enthusiasm.

As the human nostril is not usually sensitive enough to detect this odor at a distance through several inches of earth, the prices of truffles would obviously be considerably higher were it not for the trained truffle-hunting pigs and dogs, which enter into the sport with great zest and are able to locate truffles under favorable conditions forty or fifty yards away. The choice between pigs and dogs is one of economy, companionship, and the area to be covered. Dogs do not tire so quickly, but they are subject to more distractions. Water spaniels and pugs are frequently used, being trained at an early age by hunting for food mixed with truffle peelings and buried in the ground. The animal is never allowed to taste a truffle, any more than a setter or pointer is allowed to chase a rabbit. A well-trained truffle dog sells for from forty to a hundred dollars.

Truffles are also found accidentally when digging or ploughing; or a hunter of long experience may use his judgment and with some confidence dig in favorable bare spots under trees of the proper kind and age; or he may allow himself to be guided by certain small flies that appear to frequent the truffle beds.

In preparing freshly dug truffles for the market, the soil is first removed by the use of water and brushes made specially for the purpose and they are then graded by size and quality and preserved in cans, boxes, glass jars, etc. The best grades are peeled and the parings sold separately at much lower prices. Truffles are used chiefly for dressing and garnishing. As they do not keep well after being exposed to the air, it is wise to buy them in small containers and use them soon after opening.

As a food, truffles are wholesome and easily digested, while their aromatic quality undoubtedly promotes the digestion of foods with which they are served. The ancients dedicated the truffle to Venus as encouraging love, and in more modern times it was a current saying that "those who wish to lead virtuous lives should abstain from truffles." Even in quite recent years, *Elaphomyces variegatus*, a fungus resembling a truffle in shape and habit, was commonly sold under the name of "Lycoperdon nut" for its supposed aphrodisiac qualities.

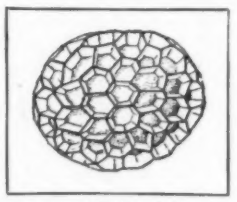
False truffles may resemble the real ones externally and grow in similar places, but they can always be readily distinguished by their spores, which are borne free on the ends of minute threads instead of being enclosed in sacs. True truffles when examined microscopically are found to contain, imbedded in their flesh, numerous, minute, transparent sacs filled with from four to eight large spores, which are beautifully and characteristically ornamented.

The common hard-skinned puffball, which occurs so abundantly during summer and autumn on the top of the ground in thin woods, is *not a truffle*. There are other "false truffles," however, which are really good, such as the "red truffle" of England, *Melanogaster variegatus*, which, although little larger than a marble, has a strong and agreeable odor and is eaten in the raw state with keen relish.

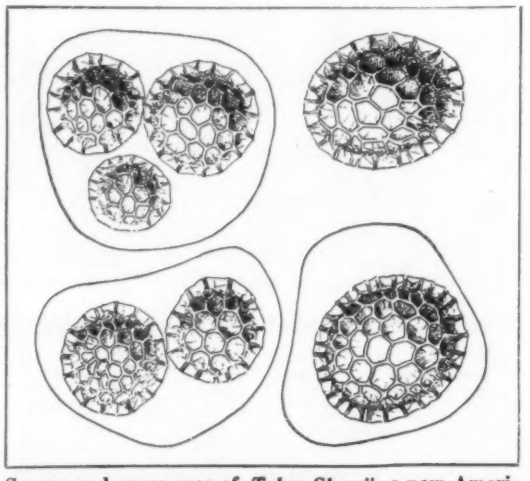
Among the various species of truffles known to science, the following may be mentioned and briefly described:

The Terfas, highly prized by the ancients, are well represented by *Terfezia leonis*, which is found in Italy and elsewhere in the Mediterranean region during the spring months and was reported from Louisiana in 1887 as occurring plentifully in red sandy land near a river. It is smooth and pure-white when fresh, becoming pale-reddish-brown on exposure to the air. The sacs contained eight spores, which were conspicuously warted. This species resembles a potato externally and is eaten raw at times, being sliced and dipped in oil, thought it is without odor and its flavor is rather insipid. Several kinds of Terfas occur in Asiatic Turkey, Persia, the Libyan Desert, and Algeria, where they form an important part of the diet of the Arabs. They grow under species of Cistaceæ in sandy soils containing lime, which are enriched by the overflow of streams after the heavy spring rains. As they develop very rapidly in favorable seasons, the soil above them becomes cracked or slightly raised, which betrays their presence to experienced eyes. Although classed with the edible truffles, they are so different

(*Continued on page 368*)



Spore of *Tuber unicolor*, found near New York City



Spores and spore-sacs of *Tuber Shearii*, a new American truffle from Maryland

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

The bumper that does not interfere with parking

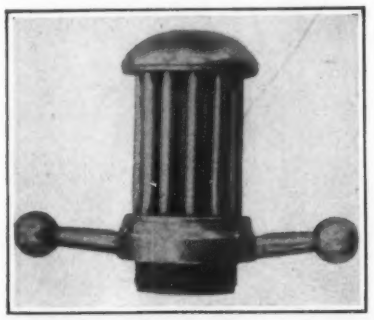
The Bumper that Is Never in the Way

BUMPERS are a very fine thing always, and a necessity sometimes; but every driver who carries them must have had occasion to curse the extra length which they add to the effective wheelbase, and the very large addition which they make to the difficulty of parking and unparking in crowded quarters. A "bumperette" of novel design is now offered, which protects the rear fenders and lamps satisfactorily, without making any material contribution to the difficulties of parking, and without interfering with free access to the spare tire.

A Condenser for the Automobile

MORE than a few automobilists have had the sad experience of discovering that the alcohol in their radiators has quietly stolen away on the wings of the wind, leaving their cooling system filled with a supposedly non-freezing mixture which is demonstrated, by the first real snappy night that ensues, to be *aqua pura*, pure and simple. The result in one instance that we know of was singularly fortunate—a weak cylinder-head gasket was the part that gave way before the push of the freezing fluid, insuring that no damage was done the casting itself; but everybody whose engine freezes up solid in this way is not so fortunate.

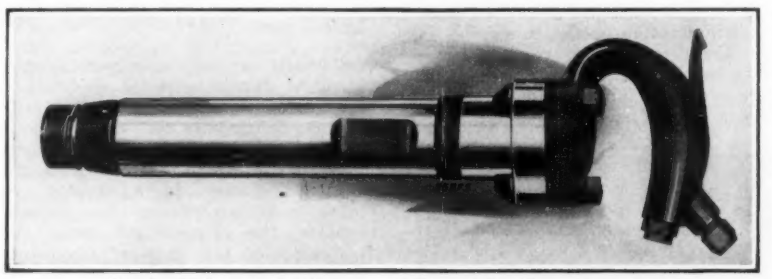
We illustrate a little attachment that insures the permanency of the several parts of the cooling mixture. It is a condenser, which in appearance and location is simply a radiator cap of rather large size and unusual design. The saving of alcohol and the prevention of unexpected freezing are but two of its advantages. It prevents the evaporation of the water, even more effectually than of the alcohol. This makes it possible to run indefinitely without the nuisance of refilling; and it also makes practicable the use of soft or even distilled water in the radiator, thus eliminating the source of the major part of the dirt that clogs the average radiator so badly. Again, with the radiator always full, the solder is seldom or never exposed to the air, and hence its crystallization is prevented; and here is avoided the source of most of the spontaneous radiator leaks that are so annoying.



Radiator-cap that serves as condenser to prevent loss of fluid from the cooling system of the automobile

Better Riveting Hammers

OUTSTANDING features of the new riveting hammer illustrated herewith include bolted construction for holding the handle to the barrel; heavy-section valve with liberal bearing surfaces; combination poppet- and piston-type throttle-valve; power in excess of all ordinary requirements; low air consumption; and exceptionally easy operation. Three alloy-steel bolts of substantial size, fitted with lock washers, hold the handle to the barrel, and enable the tool to be taken down for inspection or cleaning with the use merely of a wrench—no vise, crowbar, or other tools being necessary. The throttle valve has the nicety of control of the piston valve, with the freedom from leakage of the poppet type. The throttle lever or trigger is made in one piece from special heat-treated spring steel, and has a long bearing in the handle which enables it to withstand a lot of abuse. The valve operates in a box of strong construction, located in the head of the barrel. It has a solid end, which makes it possible to take it apart without recourse to a screwdriver. This construction also permits a compression chamber in the valve box, which cushions the piston on the return stroke and prevents it from striking the handle. The exhaust is through the side of the barrel near the handle, and can be steered in any direction by the operator.



Newly designed riveting gun with outstanding advantages

The All-Weather, Noiseless Motorcycle

IN three points the motorcar scores heavily over the motorcycle: in comfort of travel, in protection from the weather, and in silence. But a new type of motorcycle recently brought out in England affords all the comfort and silence of a car; while also great strides have been made in protecting the rider from mud thrown up by the wheels.

To test the silence of this new machine, two observers were stationed at a certain point, towards which a standard car and the new all-weather cycle travelled. The distance at which the vehicle was first heard was carefully measured. The car became audible at a distance of 134 yards from the observers; the motorcycle, which is fitted with a three-horsepower sleeve-valve engine, was first heard when 70 yards away.

The engine is completely enclosed, also the chain transmission. The frame is triangular and of a new design giving great strength and rigidity at low weight. The saddle is supported by a link and two long and powerful springs. Legshields of ample size protect the rider in bad weather, while the engine and its working parts are quite as well protected as in a motorcar.

Vaporized Metal

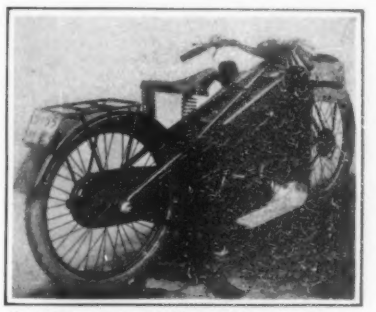
BRONZE-covered statues, copper-covered shingles, concrete piles or railroad ties, are some of the possibilities ensuing from a process for spraying metals, which after years of study is approaching perfection at the U. S. Bureau of Standards.

The essential of the process is that the metal is first vaporized by the use of electricity, and then sprayed on to the surface to be coated by means of a powerful blast which congeals it to the solid form as quickly as it strikes the surface. Applications of the method, which results in a firm coating of metal upon any surface to which it is applied, are many and varied. Stone, wood, metal and glass are all equally suitable basic surfaces. Pottery may be successfully coated with metal, pointing to important developments in ceramics.

An important application is in the use of the metal coating in building construction. Shingles may be made fire-resisting by coating them with copper, which weathers well and produces an artistic green color on the roof. Experiments are already being made along the lines of copper-coating other roofing material and stucco.

Soldering of metal to glass, a difficult problem, has been easily accomplished by means of this method. The glass is first coated with a layer of copper and the metal connection is then soldered to the copper. Processes somewhat similar are used in the soldering of aluminum.

On the decorative side the uses of the method are many. Statues or other sculptured designs may be hewn from soft and easily worked stone and then coated with bronze, giving the effect of a bronze statue and weathering equally well. Gold and silver plating or decoration may be applied in the same way to furniture or table ware.—*Abstract from Science for* November 9, 1923.



British motorcycle that possesses several features heretofore obtainable only in a regular automobile

A Protecting Cover for Shallow-water Cables

SUBMARINE cables lying in the neighborhood of the coast must be protected in the water as well as on land against the chafing influence of the movements generated by the waves. Till now there has been used a flexible armoring of thick steel wires, which protected the inner parts of the cable very well. But this kind of armoring has the drawback that it cannot be made flexible enough to follow the forms of the cliffs and stones on rocky coasts. Such a steel-armored cable, when lying on rocky shores, was partly on the ground, and partly hanging in the air. Consequently the stresses on the cable were far from uniform; one part was violently moved by the waves, the other one remained absolutely quiet.

To a new cable, laid recently on the Norwegian coast by the Siemens-Schuckert Works, a new kind of protection was applied, which enables the cable to conform closely to all unevennesses of the ground, under water as well as on land. This new armoring consists of link boxes of cast iron which overlap each other and are arranged in the manner of ball-and-socket joints. In consequence of their great flexibility these link boxes follow with the utmost accuracy the topographical formation of the sea-ground as well as of rocky coasts. In order to avoid all movements, the cable armored in the manner just described is fixed on the rocks and on fitting parts of the coast with iron clamps. The cable is arranged in the ship's hull with-

Not the latest sea-serpent—merely a scheme for protecting cables at and near their landing places

Electric washer that clamps in place upon any tub

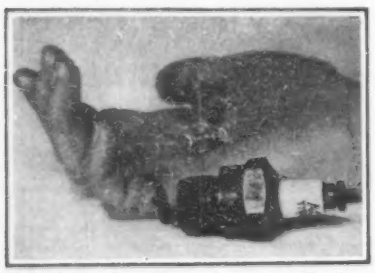
out the link boxes and it is also laid out without them. After the end of the cable is brought to land these link boxes are installed. On the dry rocks of the coast, this is simple enough. In the not-too-deep parts of the sea the laborers take the cable after being laid out into a boat and install here the link boxes; installation of the clamps is made during ebb-tide. On the deeper parts this work is done by divers.

The Hose-Holder for Fire-Fighters

NO longer is it necessary for the fire-fighters to struggle with a big hose, filled with an unruly snake of water that whips and struggles to get away from them, and calls for the heaviest kind of handling in keeping it under control. An Atlantic City inventor has put out a big, heavy, nozzle-holder which holds the most powerful stream of water steady as a rock. Not alone does it save the display of brute strength which we are accustomed to see at a fire; it saves the services of three firemen to each nozzle and releases them for more active work. Also, it means that once set, the stream will be directed without deviation or uncertainty upon the spot at which it is aimed. The hose-holder comes in two models. There is the type that clamps upon the side of the fire truck, as illustrated; and there is a ground stand, for independent use without any further support. At a recent demonstration in Atlantic City, twelve streams were shot from a single ladder-truck without being touched by human hands after they had once been set.

An Umbrella for the Spark Plug

THE little device illustrated, it is claimed by its manufacturer, catches the flying oil and prevents it from fouling the spark plug. It is attached by sliding it over the ground electrode, after which the slot is closed by bending the shield upwards over the electrodes.



Keeping the oil and soot off the spark plug

An Electric Washer for Any Tub

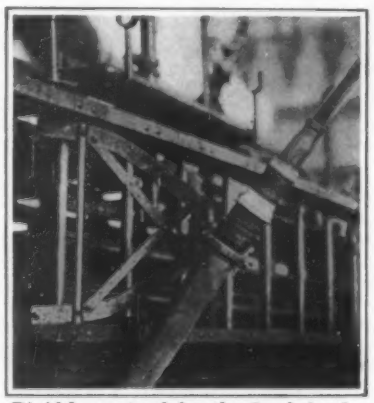
A DECIDEDLY ingenious cylindrical electric washer that clamps upon any tub or washboiler is different from others now on the market. Inside the cylinder is a little motor that water does not hurt. Neither does it drip oil. The motor runs a four-blade fan situated a few inches from the base of cylinder. This fan does the work by shooting out jets of water showing five pounds to the square inch by test. Water enters the cylinder through small holes surrounding the orifice of the jet. When the water is thrown out it strikes along the sides of the tub, swirling the clothes with it in the process of cleansing.

Paring the Phonograph Needle Without Removing It

THERE is more than one good reason why a fiber needle should be used when records on phonographs are being played. There has, however, been the tiresome task of removing the needle from the tone arm in order to cut it off after once having been used on a record. A Chicago manufacturer has now perfected a small metal cutting device that cuts the needle without removing it. It is run under the needle as shown in our illustration, and the lever pressed down by the first finger. This operates a cutting knife. Back of the cutting knife a small receptacle catches the discarded part of the needle.

New But Simple Method for Changing Cast Iron Into Steel

ONE of the most interesting developments in the realm of iron foundry practice which has been announced in several years, is the result of extensive experiment in research, largely during 1923. The findings are somewhat sensational and revolutionary. A method has been discovered of heat-treating gray or white cast iron so as to render it much more easily machinable and at the same time to bestow upon it greater strength



Rigid hose-stand for the fire brigade, which releases the firemen for better work than holding the hose

than it has ever been possible to develop heretofore. Not only have the machining qualities been greatly increased or benefited, but the strength and pliability of the iron has been strikingly augmented. Tensile strengths as high as 98,000 pounds per square inch have been obtained together with a limited amount of pliability and also marked resistance to shock and fatigue stresses.

The most interesting and notable feature of this new process is the conversion of white iron into a product not only equal to but superior to malleable iron, in a period of time much shorter than that required in the regular malleable process.

The inventor of this process is Alexander K. Schaap of Brooklyn. The process, as thus far developed, is exceedingly simple and consists in heating cast iron to a temperature shortly above the temperature of 1600 degrees Fahrenheit, protecting it in a muffle surrounded by a gas flame and open at the top. In the case of gray iron, as soon as it has reached the proper temperature, the muffle and its contents are removed from the furnace and allowed to cool in the open air, the casting being protected from drafts by placing a cover on the top of the muffle. The muffle itself is made of wrought iron and it has been found that this is the only material that can be used to obtain the results desired, muffles made of clay, graphite, steel and other metals being used without success. By this method it requires only about fifteen minutes for the iron to cool to a black heat after which it is cooled in the air.

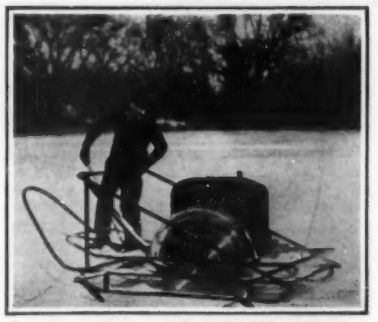
The method as outlined above has been in continuous use for more than a year, chiefly for the purpose of softening gray iron for machining purposes and

The fiber needle may now be used without the necessity of removing it from the machine to trim off the blunted end

particularly for making automobile piston rings. It may be stated according to the claims of developers that either gray or white cast iron is not only converted into a product similar to malleable iron but into one which has many of the properties of steel. If the results turn out to be as favorable as now appears probable, the process will mean the shortening of the time of converting white iron into malleable iron to less than an hour instead of 72 hours.

The Magnetic Susceptibility of Gases

THE method used in an interesting investigation by A. P. Wills and L. G. Hector was that of balancing the gas magnetically against an aqueous solution of nickel chloride. By varying the concentration of the solution it could be given a susceptibility approximately the same as that of the gas; then by varying the pressure of the gas or the temperature of the gas and soution, both could be given the same susceptibility. A manometric balance of great sensitivity enabled the observer to tell when the susceptibilities of the gas and the solution were the same. For both paramagnetic and diamagnetic gases, formulas are derived from which the susceptibility may be calculated from pressure and temperature observations on the gas when it is magnetically neutral against the solution. The volume susceptibility under a pressure of the atmosphere at the temperature 20°C was found to be $+0.1447 \times 10^{-6}$ for oxygen; -1.64×10^{-10} for hydrogen, and -0.81×10^{-10} for helium. The result found for helium is about 25 times less than Tänzler's value, but when substituted in the formula derived by W. Pauli, Jr., for the diamagnetic susceptibility of a monatomic gas, it yields a result bearing on the dimensions of the atom which is compatible with our knowledge from other sources.



Ice saw that works directly off the motor

Sawing Ice in a New Way

DOING away with the usual countershaft transmission of the conventional motorized ice-saw, the latest machine of this description uses the small-car engine, direct-connected to an inserted-tooth buzz-saw. The resulting elimination of weight is a factor of importance, and in addition the cutting capacity, it is said, is increased. The frame of the apparatus practically surrounds the rapidly revolving saw, protecting anybody who might come too close to it for comfort. It is entirely self-propelling on smooth ice, and has a cutting speed of three feet per second with a nine-inch cut.

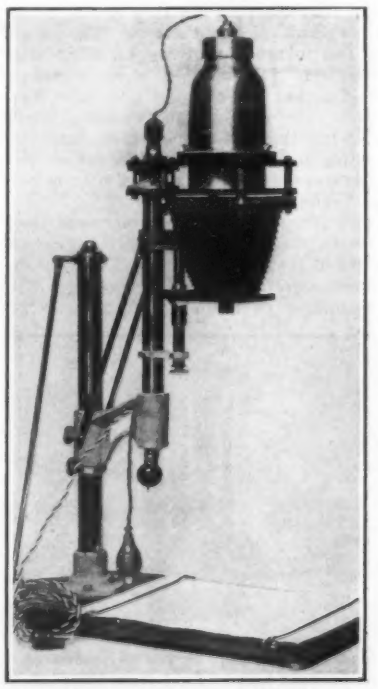
New Automatic Enlarger

A PROPER darkroom is no longer required for the use of the enlarger illustrated here; any room can be used after having been darkened. The special feature of this apparatus is a ruby lamp mounted to the foot of the second column; this lamp is controlled by a double switch, which also controls the main enlarging lamp.

A first pressure on the switch lights the ruby lamp, so that the sensitive paper can be placed in position, when the switch is pressed once more, the ruby lamp is cut off and the main enlarging lamp thrown into the circuit.

A few seconds suffice for the exposure, if fast bromide paper is used, then the ruby lamp is switched on again, and by its light the enlargement is developed.

The vertical column of the apparatus carries scales which indicate the necessary extension for the camera and its distance from the base plate. Once the scales have been properly adjusted, no further adjustment is required.



Enlarging without a special darkroom

This vacuum-held rubber hook will support a twenty-pound overcoat

The Vacuum Hook

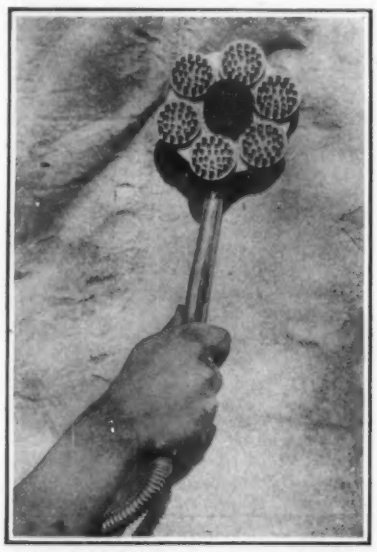
GREAT holding power is claimed for this rubber vacuum-cup with flexible rubber shank. Up to weights of twenty pounds it will firmly support whatever may be hung on it—it is even used as an overcoat hanger. In window-dressing displays it should be found of great utility. It is claimed to provide a perfect adhesion to glass, marble, enamel, metal, polished wood, or in fact any non-porous surface, without the use of glue, paste, stickers, or any adhesive substance.

The Self-Sharpening Lawnmower

WHEN a lawnmower is sharpened in this device it is necessary to remove nothing but one wheel. In the place of this wheel a clutch pulley is fitted and this serves to turn the blades of the mower while they are being sharpened. Powdered emery dust or carborundum is placed on a piece of thin cardboard and a thin paste is formed by the use of a little machine oil and the reel draws in the compound as the mower is in motion. This compound on the cutter blades of the reel serves to sharpen the blades and the cutter bar at the same time. The motive power for running the device is furnished by a one-quarter horsepower electric motor.

A Bigger, Better Bath-Spray

IN this bath spray the water sprays through holes in the metal container, back of the applicator portion, instead of from rubber prongs as in so many sprays. Six groups of rubber prongs are arranged in a circle around the outside of the container while in the center a round piece of sponge rubber is placed for use as a sponge. A sanitary feature of this spray is that the applicators may be removed for cleaning behind them.



Bath spray that gives a more effective shower of water

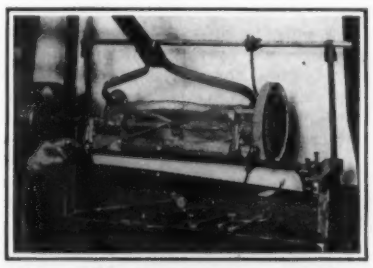
New Wood-Drying Process by Ozone

THERE are actually two principal methods for drying wood; open air and steam kilns.

The open air process requires from four to ten years, while modern industry requires a prompt supply of material. Moreover it entails the constitution of an enormous stock and the tying up of large capital.

The steam kilns produce a dried wood but the amylaceous and the resinifiable substances undergo slow oxidation which is accompanied by contraction in the contents of the cells; as a result the wood gradually shrinks, the starch which still remains unaltered in the cells attracts parasites and gives rise to the formation of mold. Moreover, these unchanged components of the cell-sap are distinctly hygroscopic, consequently the wood absorbs moisture again from the air. The general effect is to leave the cells empty, thus rendering the wood brittle and lifeless.

The process of seasoning wood by



Sharpening the lawnmower without taking it apart

ozone produces a material well dried and seasoned. As a matter of fact, no process is capable of producing the same results as natural seasoning unless it provides for the oxidation, without elimination, of the organic components of the cell-sap. If an artificial oxidizing agent is employed for this purpose, it must act rapidly; it must penetrate to the innermost portions of the wood without affecting the ligneous tissue, diluting the sap, or discoloring the wood, and it must leave no residue. The oxidizing agents employed in chemical industry cannot do that. Ozone, on the other hand, fulfills all these conditions and is capable of reproducing exactly the phenomena of seasoning by exposure to air, but at a rate many hundred times more rapid.

The ozone wood-drying process was invented by Mr. M. P. Otto, a French Civil Engineer, Doctor of Sciences, who has devoted his studies to ozone and its results in all kinds of spheres. After a long course of experimental work Mr. Otto has now established it industrially.

There are now in Paris and near Paris two plants which dry wood for all kinds of industries, the demands of which are so extensive that those two plants cannot meet the requirements of the manufacturers. Some more kilns are to be erected in the near future.

In Italy, at Seregno near Milan, there is another plant, and England is about to adopt the process.

In the ozone process the wood is submitted successively to the action of hot air, or ozonized air and of a mixture of ozonized air and hot air. The duration of the treatment varies, according to the nature and the thickness of the wood, from four to twenty days. In that period *green wood* is converted into seasoned wood possessing all the characteristics of wood exposed to the action of air for ten years. There is no case hardening, checking or warping. It must be pointed out here that wood brought green to the kiln comes out ready for use; therefore it is not necessary to stock before or after the process.

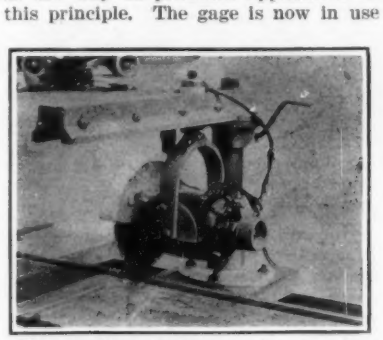
The manufacturers using the process in France are unanimous in declaring that, after being finished, all articles show a perfect polish equal to ivory, which proves that the wood is a compact and unalterable body. The "Conservatoire National des Arts et Métiers" has examined the process in its experimental laboratory and fully confirms the results claimed by the inventor.

A Bulldog Splice for Wire Rope

THERE are legions of splicers, but most of them are larger than the wire. It has remained for a Mansfield, Ohio, manufacturer to produce one which when applied is no larger than the wires spliced. This simple little appliance is made of bronze and has a number of teeth on the inner surface, whose purpose is to grip the stranded conductor and hold on tightly. It is closed by means of a hammer, and no solder is needed. The finished splice is covered with tape. There has been a long-recognized need for just such a thing as this, where work must be done in a hurry, and with portable tools.

Measuring Strains by Electricity

THE measuring of the strains of bridges, skyscrapers, airships and structural material in general has been made possible by electricity through the use of a device recently perfected by the U. S. Bureau of Standards. The device has the great advantage that results may be read or recorded anywhere, although the gage itself may be in a difficult and inaccessible location. The principle employed by the inventors, Messrs. B. McCollum and O. S. Peters, is that of the varying electrical resistance of many closely adjacent thin carbon plates when subjected to a compression or pulling strain. Heretofore there had always been insuperable difficulties in the way of practical application of this principle. The gage is now in use

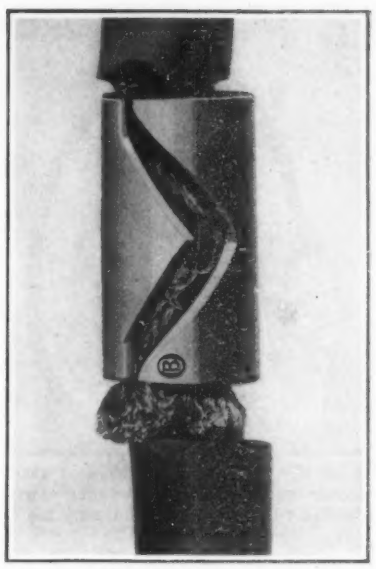


The machine that runs through the entire catalog of woodworking operations

in a series of tests of impact strains on highway bridges that are being made at the Iowa State Agricultural College. The gage has also been tested on railway bridges. The device is small in size, being about 10 inches long, less than five inches wide, and about an inch and a half thick. The reading apparatus is a specially constructed voltmeter. By connecting wires from the instrument to an oscillograph graphic records of stresses have been made. The invention is not only very sensitive but it recovers itself so quickly after the strain has passed that it may be used in the measurement of vibratory or transient strains with a duration no greater than one thousandth of a second.—*Abstract from Science for Oct. 7th*, 1923.

The Woodworker's Jack-of-All-Machines

WE illustrate a clever new woodworking machine-of-all-work, which will do cross-cutting, ripping, mitering, bevelling, matching, molding, irregular shaping, dadoing, routing, sanding, boring, turning, fluting, tenoning, and panel



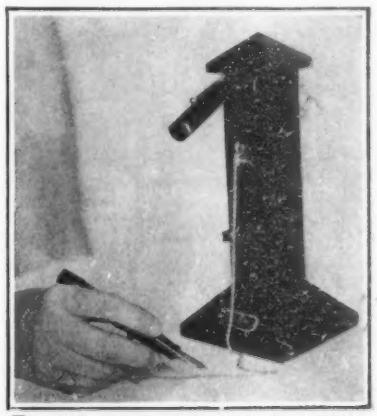
A wire splice that is no larger than the wire yet holds like grim death

raising—on any rake or bevel. It sounds like a large order, but the machine looks capable of filling it.

There is a base casting, which supports a sliding vertical column, elevated and lowered by screw and bevel gears with crank attached. One turn of the crank raises the column one-eighth inch. The column supports a rigid one-piece horizontal arm, machined on the inside to receive a slide-block which carries a yoke-and-motor assembly. This horizontal arm is thirty inches long and swings right or left in a complete circle. Graduations at its point of contact with the column enable the operator to set it quickly to cut any angle. The yoke is suspended from the slide block by a square-head shaft which seats in a milled way in the top of the slide block. The motor may be turned to right or left and seated in any of four 90-degree positions. The motor is pivoted in the yoke, swinging from horizontal to vertical and being held in either, or any intermediate, position by clamp nut. Ready means is provided for quickly determining the horizontal, vertical, and 45-degree positions. The machine works with any stock up to two inches.

Fountain Pen for Public Places

PEN service for those who have no pen of their own is furnished by this recently patented writing device. The illustration shows the pen removed for writing. After use, the chain to which the pen is attached is pulled taut and run back in the base. It can be locked in any position for convenient use. A pull of the chain to the side between the small pulleys catches the



Fountain-pen service for the public writing-station

With this simple combination of ammeter and variable resistance, any desired rate of battery charging may be obtained

chain and holds it till released, while within the base is a weight which pulls the chain back into the base after the writer releases it from its position between the rollers. Its operation is much the same as that of a windlass.

Hoisting by Air

THE air-motor hoist illustrated on this page employs a balanced three-cylinder air-motor which operates in either direction and at any speed or hoist at any speed. A safety stop lever prevents over-running the top or bottom of the travel of the hoist. The automatic brake holds the load at any point for any time, regardless of the air pressure. The new hoist is marketed in five sizes, from five hundred pounds up to five tons.

Variable Charging with Minimum Fussing

ANY user of constant potential, with the aid of the simple connector illustrated, may enjoy the use of modified constant potential without the bother of buying a lot of variable-resistance connectors. The appliance consists of a special clamp fastened to the bus bars, into which is built a special carbon-pile resistance, together with an accurate-reading ammeter showing just the rate of charge going into the battery. By turning the knob below the meter, practically any desired rate of charge may be obtained. The connector is marketed with eighteen inches of No. 4 rubber-covered cable, and special battery connection.

A Novel Pump of Fine Performance

AMONG the interesting experiments which come to our attention, a high place goes to the novel pump assembly which is now being tested out in the laboratory of Detroit University by Charles W. Jackman. The left-hand member of our series of five photographs shows the set-up which has been used in these tests. A trunnion has been brazed to the gear cover and a ball bearing (not visible) fitted to it. A second ball bearing is fitted to the shaft of the pump, and the whole affair including the short pipe-connections pivots on these bearings. A large tank is placed below the pump and the inlet is through a short vertical pipe. The discharge is from the top through the venturi meter and throttling valve. The pump is on its side to accommodate the connections. The motor power available is a horizontal steam-engine, much larger than necessary, but giving a steady though flexible flow of power.

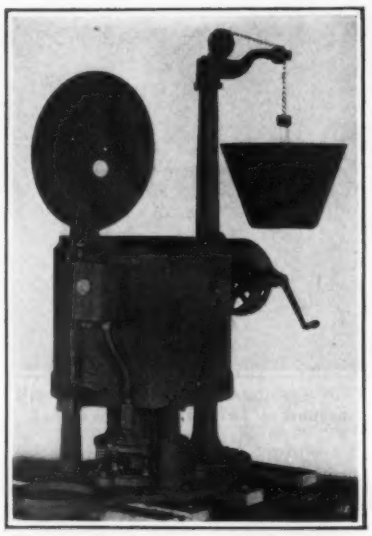
As for the pump itself, the present model is fitted with balance pistons on the impeller to eliminate end-thrust. The large out-swept annular volume is displaced twice in each revolution, giving a big output for the size of the pump. The discharge is perfectly uniform and pulseless. The pistons are in constant contact with the casing, making the leakage small. There is no contact between pistons and abutments; and that between impeller and abutments is a true rolling contact on circular surfaces. The gear timing may vary within wide limits. The rubber covering of the abutment segment (shown in the final view) eliminates leakage between the abutments and the impeller during the period of rolling contact, the rubber being then compressed slightly. As a result of this, the volumetric efficiency is something like 90 per cent.

Centrifugal Extractor of Interesting Design

IN the electrically-driven centrifugal extractor shown herewith, all belts, countershafts, etc., are eliminated. The motor is mounted directly upon the spindle of the machine—a distinctly modern tendency in the effort to get away from driving complications, and one to be observed in a very wide variety of electrically driven apparatus. The machine may be brought up to speed under full load in ten seconds and stopped in twelve. By means of a novel compensating feature in the assembly of the motor with the chip-pan unit, all the vibration so common to this sort of machinery is transferred to the base, where it is easily controlled.

The lower motor-bearing carries radial loads only; the upper bearing carries radial loads, as well as the thrust load of the pan assembly, spindle and chip load. The weight of the entire assembly is carried by a pivot bearing in the base of the machine. The machine is equipped with a safety cover which automatically locks the drum control whenever it is raised.

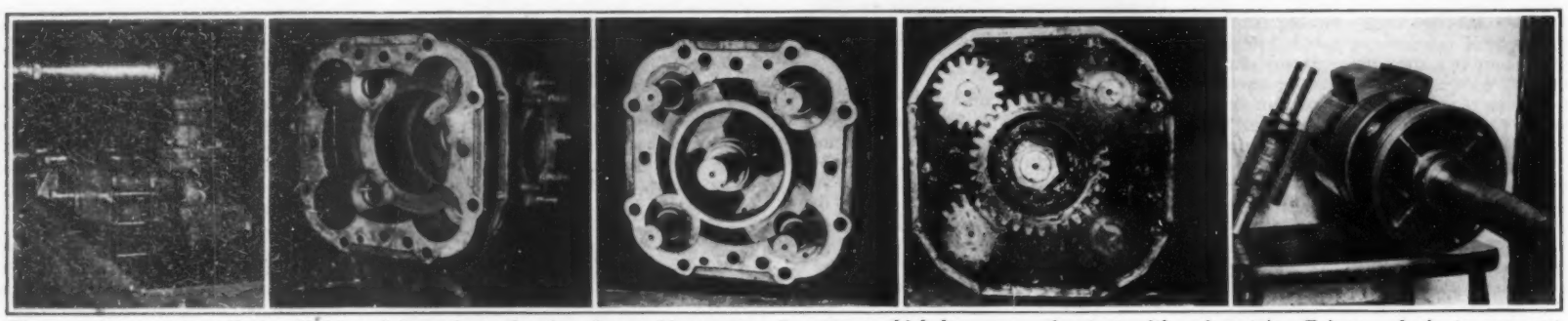
Not only is safety obtained by thus preventing the operation of the machine except when the cover is closed, but splashing of oil is also prevented. The chip pan has a capacity of two bushels, in the size now being marketed; but the same application will be made to other sizes in due course. The machine has an obvious availability for a large range of extraction work.



Electrically-driven centrifuge of unusual simplicity in design and operation

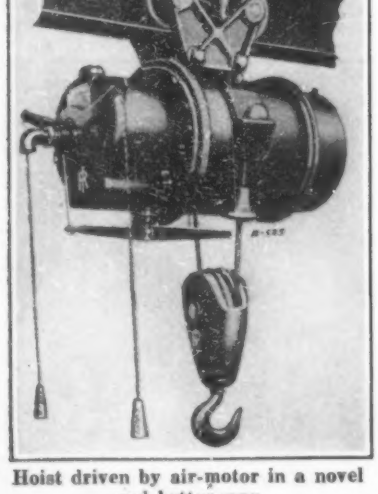
An Electric Hand-Shaper

ILLUSTRATED herewith is an electrically operated hand-shaper of interesting design, shown at work. A specially patented cooling device permits the entire assembly, motor and all, to be thus held in the hand while developing a speed, under load, of 8500 revolutions per minute. Without the load the one-eighth-horsepower motor attains as high a speed as 18,000 revolutions. The tool is obviously an extremely convenient one for a wide variety of small shaping jobs.



The complete test installation (left) and four views showing the working parts of a pump which has run under test with volumetric efficiency of ninety per cent

load within the rated capacity of the machine. The manufacturer emphasizes that this is not a direct-acting hoist, consisting as the latter do, essentially of only a plunger and a case. It comprises an air-motor, geared through a mechanical train to a hoisting drum. Throttle graduation is very fine, insuring instant and complete control of the characteristic of the plant in this connection is that, unlike many algæ, it can flourish in water in excess of ten feet deep.



Hoist driven by air-motor in a novel and better way

New Discovery in Mosquito Suppression

THE discovery that a certain kind of alga growing in still or stagnant water has an important use in partially limiting the growth of mosquito larvæ in such waters, announced in 1919 by a Spanish professor, has been supplemented by another Spanish scientist who has now found a new and more effective species of water plant, identified as *Chara Hispida*, which keeps the water in which it grows completely free from these pests. This plant was found growing in the swampy regions near Valencia; pools in which it occurred were found to be completely free from the larvæ, while other pools from which *Chara Hispida* was absent were found to be well populated with the wigglers.

These observations made in the swamps were later confirmed by small scale experiments, in the course of which the larvæ of Stegomyia were introduced into water in which the *Chara* plant was growing. They all died. Further observations in the laboratory and in nature have confirmed the essential antagonism between *Chara Hispida* on the one hand and the different kinds of mosquitoes (Stegomyia, Culex, and Anopheles) on the other. The hemp retting ponds near Valencia were later found to contain a rich growth of *Chara*, and to be entirely free from mosquitoes.

Further work is being done with the view of enlisting the aid of this plant in mosquito eradication. A valuable

The motor develops 8500 revolutions under load, but can be held in the hand without discomfort

The Heavens in May, 1924

Some Details About the Transit of Mercury, Occurring this Month

By Professor Henry Norris Russell, Ph.D.

THE present month is noteworthy for an unusual phenomenon, visible throughout the United States—namely, a transit of Mercury across the sun's disk, on May 7th. On this date the planet comes directly between us and the sun, so that it is visible as a small black spot upon the solar disk—too small, however, to be seen with the unaided eye, as it is only twelve seconds of arc in diameter. A good field glass, equipped with a suitable shade to diminish the sun's glare, should show the planet—and this may be a good time to remind ourselves that an old, fogged photographic plate, developed until it is so black that the sun can just comfortably be seen through it, makes an excellent shade for this purpose.

The smallest telescope should show the planet distinctly. The shade-glass should in this case be placed between the eye-piece and the observer's eye, as any home-made affair will inevitably be of such optical quality that, if placed in front of the objective of the telescope, it would spoil the image completely.

The planet, as seen from New York, begins to enter upon the sun's edge at 2:42 P. M., Eastern Standard Time. For points on the Pacific Coast the moment of entry is not quite a minute later, by Greenwich time (though obviously three hours earlier by local time). For all American stations the point of first contact is very near the uppermost point of the sun's edge, as it appears in the sky at the time.

Three minutes later the whole disk of the planet will have entered upon the sun's face; and from this time until sunset it will be visible as a black spot moving slowly downward and to the right. The planet's track takes it almost centrally across the disk, and the full transit requires about eight hours; but long before that time the sun will have set for the western world. The end of the transit will be visible in Europe, just after sunrise on the 8th.

With a field glass, little more than the existence of a tiny black spot can be detected, and it may be hard to distinguish it from a sunspot, if there happen to be many of the latter—which is unlikely, as we are near the time of minimum. By making a sketch of any spots that are visible before the planet enters upon the sun, identification of the invader can be made certain—as also by the planet's motion. The observer must remember, however, that the sun appears to turn, *relative to the horizon*, as the day advances; and that a spot which is on the right-hand edge of the sun at noon will seem to shift about 40° toward the bottom of the disk before sunset—and be on his guard against confusing this apparent motion of the sun and his spots with the real motion of the planet. The changes in the distance of the planet from the sun's edge, of course, afford a safe guide.

With the telescope it can be seen, if the air is steady enough, that the planet is perfectly round, with a hard, sharp edge—unlike the sun's spots, which are irregular, and show less contrast. Under good conditions, too, one may note that the planet looks darker than the spots—black, while they are brownish—a proof that the spots are not perfectly dark, but shine with a light of their own, fainter than that of the rest of the sun.

The most important observations, from the astronomical standpoint, which can be made during the transit are determinations of the exact times when the planet first invades the sun's limb and when it is completely projected upon it—and perhaps also photographs showing the planet in front of the sun: the object of both sets of observations being to find the exact position of the planet in the sky, compared with the sun at a known instant. In these days of radio time signals, good observations of the time of internal contact may be made by amateur observers (with telescopes of at least six inches aperture, and good seeing), provided they have reliable watches, and compare them with the radio signals both before and after the transit, without attempting in any way to regulate them between times.

The Schedule of the Transits

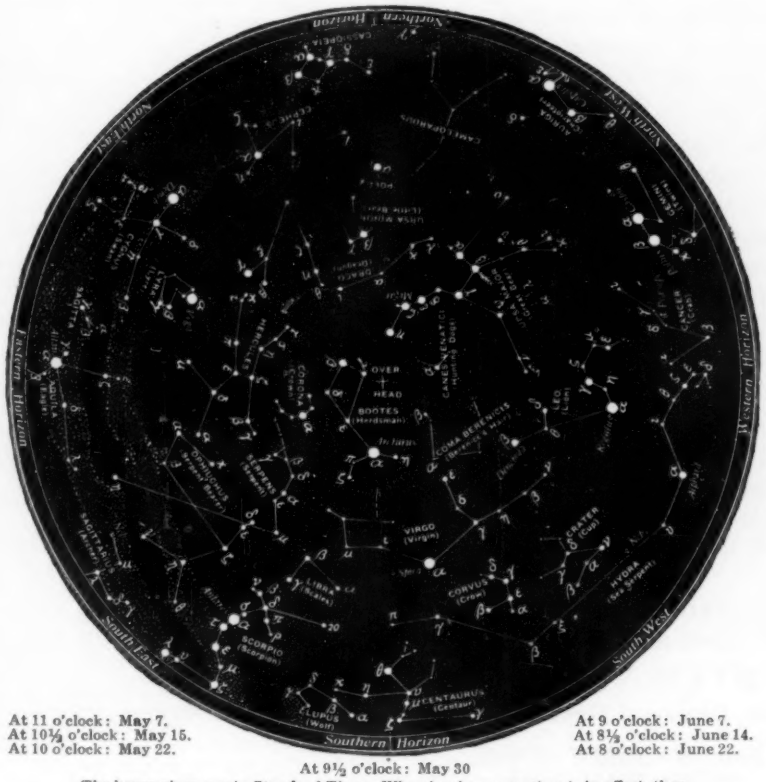
Mercury goes around the sun four times every year, and catches up with the sun three times. Why then are these transits so rare? As everyone knows, the reason is that the plane of Mercury's orbit is inclined seven degrees to that of the earth's, so that the planet usually passes far above or below the line joining us to the sun. Only when a conjunction occurs close to the intersection of the two orbit-planes (the line of nodes), can there be a transit. The earth reaches these points in its orbit upon May 5th and November 7th, and all transits must occur within a few days of the one date or the other.

The law of their repetition has been worked out in beautiful detail by Newcomb. In 46 years Mercury goes around the sun very nearly 191 times, and therefore catches up with the earth 145 times. At only six of these conjunctions is he within the limits just mentioned, so that the average interval between transits is about eight years. The actual interval between successive transits may be either 3½, 7, 9½, or 13 years, according to circumstances; but it never exceeds the latter value. November transits are about twice as numerous as those in May; because in the former case Mercury is much nearer the sun and may then be a greater number of miles from the plane of the ecliptic without getting out of the line between us and the sun's upper or lower edge.

The 46-year interval is not quite exact, though series of May transits succeed one another at this interval for about 400 years, and of November transits for more than 800. A longer cycle, of 217 years, during which Mercury makes almost exactly 901 revolutions, is much more precise, and transits, under very similar circumstances, succeed one another at this interval for thousands of years.

The last transit of Mercury was on November 6th, 1914, and was visible in the United States, as were those of November 13th, 1907, and November 10th, 1894, in whole or in part; also that on May 9th, 1891—the last previous May transit. The next transit, on November 9th, 1927, will be invisible in this country, the opposite side of the earth at this time facing the sun. The four following transits, on November 11th, 1940; November 13th, 1953; May 5th, 1957; and November 7th, 1960, will be at least partially visible in this country.

One further interest attaching to these transits may be mentioned. Since Mercury moves much faster near its perihelion than near its aphelion, the times of the transits are altered when the perihelion and aphelion move, giving us one of our most accurate means of determining such motion. It was in this way that the peculiar motion of Mercury's perihelion was first discovered—to be a puzzle to astronomers for a generation, and to be at last accounted for by Einstein.



At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.

At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

At 9½ o'clock: May 30

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on May 7, etc.

NIGHT SKY: MAY AND JUNE

The Heavens

The Milky Way sweeps far along the eastern horizon—too low to be conspicuous itself, but marked by many bright stars. Scorpio is in the southeast, not fully risen. To the left is Ophiuchus, now brightened by the presence of Jupiter. Then comes Aquila, due east, and Cygnus, in the northeast, with Lyra above. Cepheus follows, and last Cassiopeia, low in the north. Ursa Minor and Draco swing high over the pole, and Ursa Major is far up in the northwest, extending almost to the zenith. Auriga and Gemini are setting, far below. Hydra stretches along the horizon from west to south, with Corvus and Crater just above and Leo and Virgo higher. Boötes is almost overhead. Far below on the southern horizon is Centaurus. The brighest stars of the constellation, Alpha and Beta Centauri, are visible at this hour from southern Florida and the West Indies; and the Southern Cross, also low on the horizon, an hour or two earlier in the night.

The Planets

Mercury is an evening star before his transit, and a morning star afterwards; but he is visible only near the end of the month, when he rises at 4:45 A. M. Venus is extremely conspicuous as an evening star, far north and very bright, remaining in sight until 10:10 P. M. on the 31st.

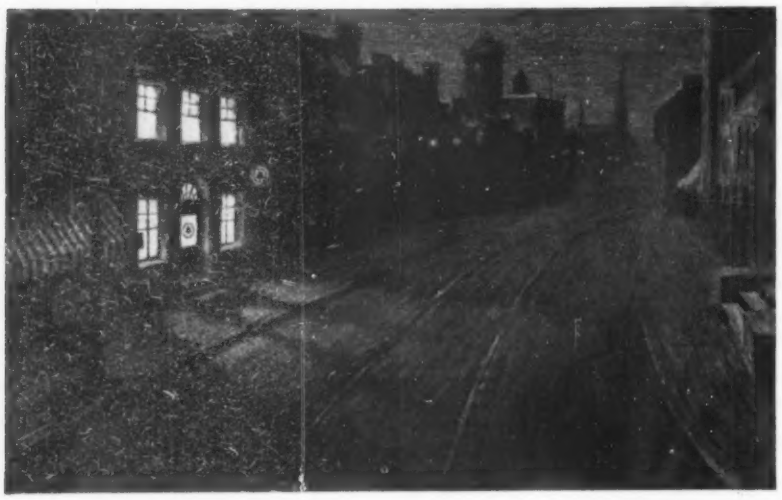
Mars is past quadrature, and steadily getting brighter and nearer as he moves slowly eastward through Capricornus. By the 31st he rises at midnight and looks nearly twice as bright as Arcturus.

Jupiter is in Ophiuchus, approaching opposition, and rises at 9 P. M. in the middle of the month. Saturn is in Virgo, crossing the meridian at 10 P. M. on the same date. Uranus is in Pisces, rising 2 A. M.; and Neptune is in Leo, setting shortly after midnight.

The moon is new at 6 P. M. on the 3rd, in her first quarter at 9 P. M. on the 11th, full at 5 P. M. on the 18th, and in her last quarter at 9 A. M. on the 25th. She is nearest the earth on the 23rd, and farthest away on the 5th. As she makes her circuit of the sky, she passes by Mercury on the 4th, Venus on the 7th, Neptune on the 11th, Saturn on the 16th, Jupiter on the 19th, Mars on the 24th, Uranus on the 26th, and Mercury again on the 31st.

Distribution of Brightness on the Sun's Disk

SCHWARZSCHILD and Defant's work, developing Schuster's investigation of the decrease in brightness from the sun's center to limb, seemed consistent with the supposition that the sun consists of a nucleus which radiates like a black body, surrounded by a cooler gaseous atmosphere which scatters this radiation. But St. John's work, developing Evershed's discovery of radial motion in sunspots, assumes that the sun is gaseous throughout, the Fraunhofer lines being produced by absorption at different levels. A paper by R. Dietzius (*Akad. Wiss.*, 131, 2a, 1) is now offered to show that Schuster's law of decreasing brightness can be explained quite as well, or even better, on this theory of a completely gaseous sun.



In the Dead of Night

In the dead of night a fire breaks out—the alarm must be given. A child is taken sick—the doctor must be called. A thief enters the home—the police must be located.

In the dead of night the American turns to his telephone, confident he will find it ready for the emergency. He knows that telephone exchanges are open always, the operators at their switchboards, the wires ready to vibrate with his words. He has only to lift the receiver from its hook to hear that calm, prompt "Number, please." The constant availability of his telephone gives him security, and makes his life more effective in wider horizons.

Twenty-four-hour service, which is the standard set by the Bell System, is the exception in the service of Continental Europe. An emergency may occur at any time. Continuous and reliable service has become a part of the social and economic fibre of American life.

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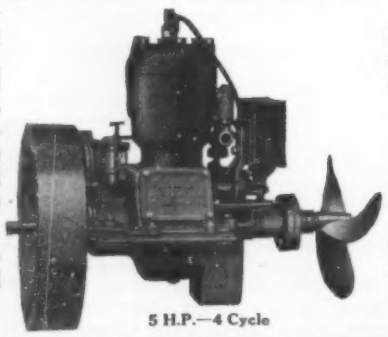

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DUBRIE MARINE MOTORS
5627 McGraw Avenue Detroit, Michigan

"This is Station ——"

(*Continued from page 303*)

could also function as a primary broadcaster, whenever something of local interest was to be put on the air.

The telephone wire transmission seems the simplest means of accomplishing the desired end. Simultaneous broadcasting by a number of stations, widely separated, has been carried on at intervals by wire transmission, for some time back. Unfortunately, however, the limitations of this method are considerable and the difficulties of repeating programs increase with the distance and the number of stations; so that while it is technically possible to do the work in this manner, from the cost standpoint it appears entirely impracticable at this time. In addition, a most serious limitation is the lack of flexibility at the repeating station, to permit it to shift from one program center to another, as it would be impossible to change the telephone wire connections without elaborate prearrangement.

Radio repeating, on the other hand, has no such limitations and possesses flexibility to the utmost degree. While only one such station—the Westinghouse station at Hastings, Nebr., KFKX—is at present in commercial operation, the success already attained with this station is sufficient to demonstrate the possibilities of this method of repeating, and to indicate that it marks the first step toward a comprehensive system of radio repeating which will, in time, cover not only the United States, but the entire world, according to H. P. Davis, Vice President of the Westinghouse company. Under this system, we are assured, it will be possible to listen in on the interesting events of the old and the new worlds.

The system is so flexible that it is susceptible of indefinite expansion without excessive cost. When completely worked out, the owner of every crystal or low-power set, no matter where located, can listen to selected programs in which the best from every quarter of the globe can be included. The primary broadcasting stations need be but few in number, but will be located where the best of program material is available.

How does this radio repeating work? Simple enough—at least now that it has been worked out by radio engineers after several years of painstaking efforts. The KDKA station of the Westinghouse organization, the pioneer broadcaster, please remember, broadcasts two waves at one time. The regular broadcast audiences are being entertained by means of the 326-meter broadcast, while a 94-meter short-wave broadcast is going out to the repeating stations. Tests have proved that the short-wave or high-frequency broadcasts go farther with the same power input than the ordinary broadcast waves. It has also been proved that daylight, which has a marked effect on the usual wave lengths, has little effect, if any, on this carrying power.

Great things are bound to come out of this short-wave transmission and re-broadcasting. Only the other day a concert broadcast by KDKA was picked up in London on a short-wave receiver, properly amplified, and re-broadcasted on the higher wave lengths used by the British broadcasters. The Pittsburg concert, via London, was picked up in Calcutta, India, and held for thirty-two minutes. This system of short-wave transmission and repeating is enabling the British audiences to listen to American radio programs, and even the French, Belgian, Dutch and German listeners-in may have an opportunity of listening to the fascinating strains of American jazz via the British repeating stations.

Doing Away With the "Pick-Up" Wires

The possibilities of short-wave transmission penetrate even deeper than this into the future of radio broadcasting. Broadcasters from time to time find it necessary to transmit directly from some point outside the studio. It may be a banquet, a baseball or football game, the ringside, the theatre or opera, the convention hall; but whatever it is, the usual studio microphone is replaced by a microphone in the field, so to speak. The "pick-up" equipment, to use radio parlance, has heretofore been connected with the broadcasting station by means of telephone or telegraph wires. Such means have been ample for the purpose, although, truth to tell, there have been many times when the broadcasters have found it difficult and, sometimes, impossible to obtain the proper wire connections, with the result that the radio audience have missed important events. And now we have

(*Continued on page 354*)

JOINTS! They cause all the trouble in fire brick linings. They're the weak links that give 'way under the heat of the furnace and that make the need for entire relining certain.

Eliminate them. Install jointless Plibrico Furnace Lining, the way the man pictured above is doing. Pounded in while plastic with a mallet, Plibrico forms a one-piece rock-like lining when heat is applied. It lasts two to four times as long as fire brick. It cuts heat loss through the setting. It can be installed by unskilled labor. It resists temperatures to 3100 deg. F.

Surely you want to know more about this long-lived lining. The big book "Refractories and Furnace Design," tells the story. The coupon brings it

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Get the FREE book

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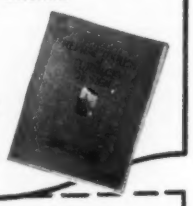

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1159 Clay Street, Chicago, Ill.
Please send us the free book.

Firm.....

Address.....

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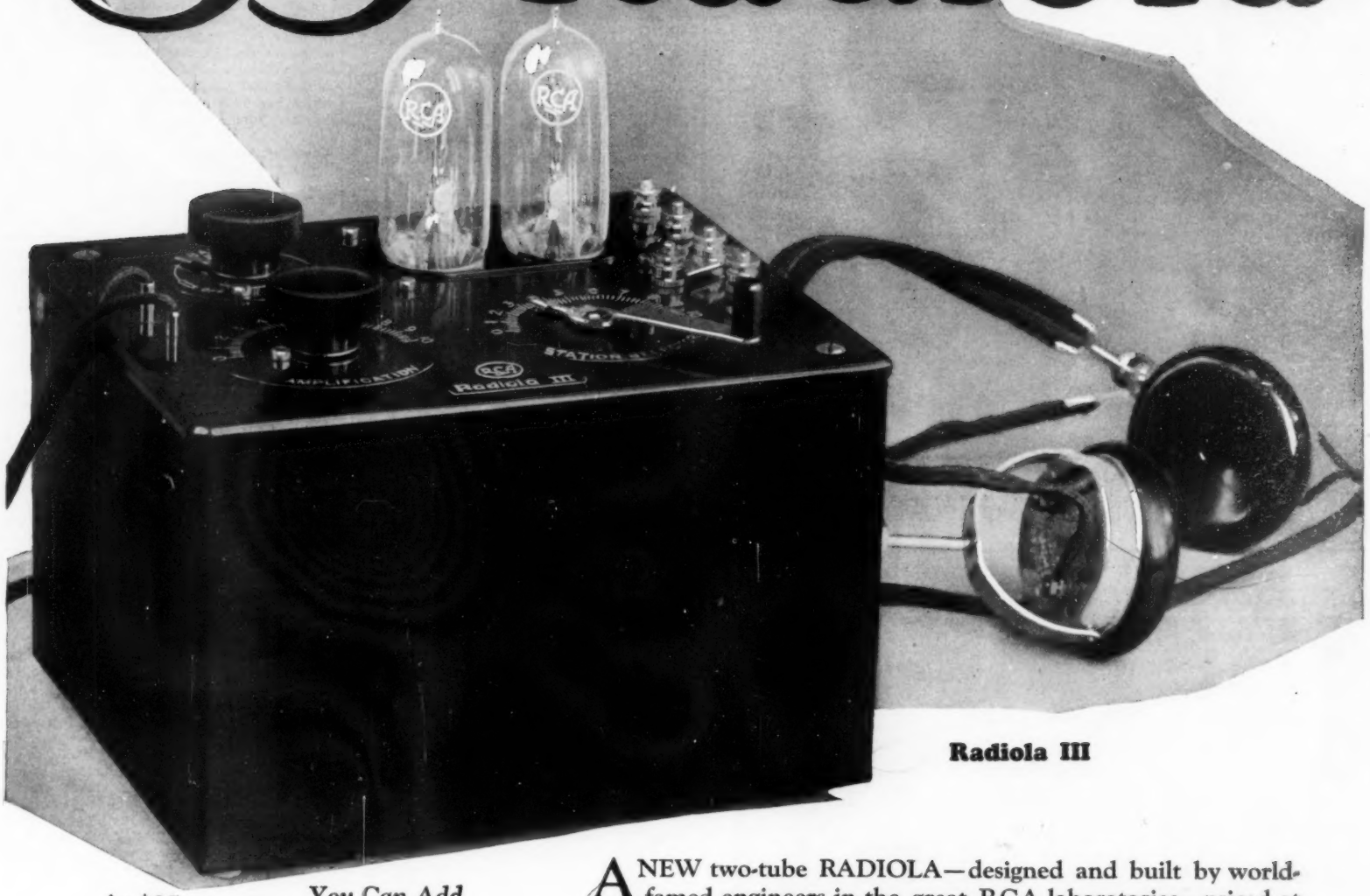
Attention.....

$35 for a *two tube* Radiola



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A NEW two-tube RADIOLA—designed and built by world-famed engineers in the great RCA laboratories—priced at less than you could build it for at home! A real RADIOLA—including the tubes and the headphones. A new model. Improved in sensitivity and selectivity. Getting distance on the headphones, and near stations on a loudspeaker. Receiving clearly—reproducing truthfully. Its thirty-five dollar price means at last that every home everywhere can tune in on the fun with a small receiver built for big performance.

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Radiola III. Two Radiotrons WD-11. Head telephones. In brief, everything except the dry batteries and the antenna.

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Radiola Balanced Amplifier (push-pull) to get long distances with a loudspeaker. Including two Radiotrons WD-11, $30

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RADIOLA III-A, the amplifier combined with Radiola III in one cabinet; with four Radiotrons WD-11, head telephones and Radiola Loudspeaker $100

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The Vortex Method is different. A good many Plants have increased their Light and Production by this low cost system—

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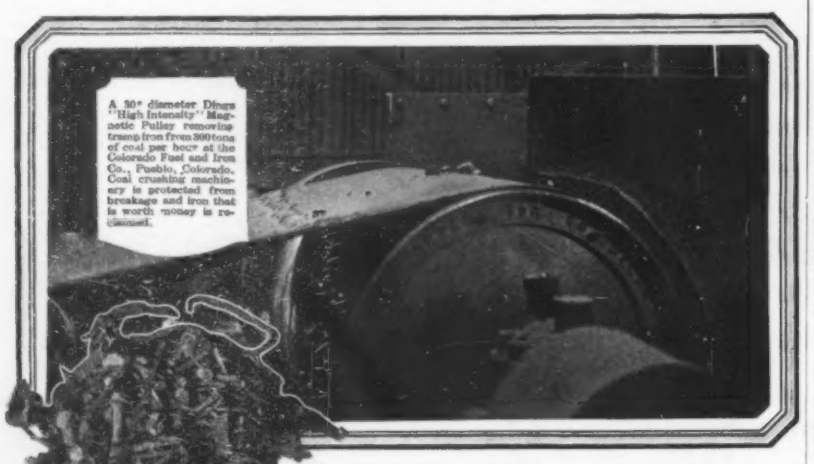

Tramp iron like this

—wrecks crushing and grinding equipment
—lowers quality of many manufactured products
—causes fires and explosions in mills

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—in mines, mills and smelters by protecting crushers from damage by tramp iron and by refining and reducing minerals and ores
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—in iron foundries by reclaiming iron from dump piles
—in non-ferrous foundries by removing iron from borings and sweepings, assuring iron-free castings
—in rubber reclaiming, by removing stray iron
—in glass plants by preventing discoloration
—in potteries by preventing black specks in china
—in power plants and pulverized fuel plants by protecting crushing equipment
—in quarries by protecting crushing equipment from breakage
—in cotton seed mills by protecting linters and hullers
—in garbage reclaiming by removing cans
—in the manufacture of drugs, chemicals, sugar, salt, food products, cattle and poultry foods, battery, tea, carbon ammunition, chicory, crucible clay, gas mantles, copra, vegetable oil, chocolate and cocoa, paper, pulp, ink, abrasives, glue, brewery products, lake, celluloid, starch, asbestos.

STRAY or "tramp" iron causes a lot of trouble. If it gets in crushers in mines, quarries or elsewhere it may wreck them, causing plant shutdown. In manufactured products — like ink, china, glass, foods, chemicals — it lowers quality. In grain elevators and mills a spark from iron in the crusher may cause a disastrous explosion.

You can't keep iron from entering raw materials — but Dings "High Intensity" Magnetic Separators will remove it wherever its presence is dangerous to equipment, raises manufacturing costs, or is a menace to quality. The list opposite suggests the wide range. Write for bulletins for each industry to—

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Separate bulletins describe each type. Ask for your copies.

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See 'phone book for branches in New York, Denver, Richmond, Detroit, Chicago, Pittsburgh, Cleveland, St. Louis, Birmingham, Los Angeles, Cincinnati, Salt Lake City.

The Scientific American Digest

A review of the technical and trade press, consisting of abstracts from leading articles announcing the newest developments in industry and engineering

Exact references to the sources from which these abstracts and quotations are made follow each abstract, the numerals referring respectively to the volume, number, and pages occupied by the original article in order that those who wish for further data may refer to the originals. Other digests appear elsewhere in this issue

Automotive

Changing to "Balloon" Tires.—Both balloon and "balloon type" tires are straight side and no expense is connected with changing from regular to "balloon type" tires on cars equipped with straight-side rims. In the case of cars using clinchers, the cost of the changeover is only that ordinarily incurred in changing from clincher to straight-side rims. On the other hand, in changing from regular cords to balloon tires on cars already in use, either new wheels or new rims are necessary, usually new wheels. On Cadillac and Lincoln cars the rims cannot be changed and new wheels are required. "Balloon type" tires can be applied with no alterations whatever to cars having sufficient fender and body clearance. This clearance must be measured between the tread of the tire and the fender at the top, forward and rear ends of the latter, also between the side of the tire and the side of the body and between the side of the tire and the outer edge of the fender. Some cars have more fender and body clearance than others, and for that reason single and double oversize "balloon type" tires are made to fit the most commonly used rims. The single oversize "balloon type" tire can be used in all cases, but when attempting to apply the double oversize, careful measurement of all clearances is necessary, not forgetting the use of chains in winter and that heavy loading of the car may produce sufficient sag in the springs to cause the fenders to strike the tires in crossing obstacles. The effect of these larger tires on the gear ratio and effective power is also to be considered.—*Ind. Rub. World* 69:6, 2 pp.

What is a Balloon Tire?—Considerable confusion already exists in the tire trade, and still more in the public mind, as to the proper answer to this question. The term has been commonly applied to a great many sizes ranging from the 29 by 4½ and 30 by 5 six-ply so-called "taxicab" tires requiring an inflation pressure of about 40 pounds, to the 34 by 7 four-ply thin sidewall tire designed for inflation pressures as low as 18 or 20 pounds. Leading tire manufacturers have therefore become apprehensive lest the public, hearing of the successful use of balloon tires at inflation pressures as low as 18 pounds per square inch, will jump to the conclusion that all tires termed "balloons" can be used at this low pressure, and that the results will be disastrous. To offset this tendency some are recommending, even for "true" balloon tires, a pressure of about 36 pounds, despite the fact that at this higher pressure much of the cushioning value of the balloon tire is lost and punctures are said to occur oftener because of the higher unit pressure between tire and road. Meanwhile it is well for everybody to note the marked distinction which exists between balloon tires and "balloon type" tires. As shown by the appended table of approved tire sizes, balloon tires are manufactured for wheels and rims of three new and special dimensions only, namely 20, 21 and 22-inch. "Balloon type" tires are produced to fit the wheels and rims now in common use. There are now 213 sizes on the approved list of the Rubber Ass'n of Am. Proper inflation pressure depends as always on the load, but contrary to the former practice the front tires require about five pounds more pressure than the rear tires when the car is empty, due to the weight of the engine. A low pressure gage should be used and the inflation uniformly maintained. For ideal comfort in a Lincoln four-passenger phæton, for example, 30 pounds front and 25 pounds rear is about right.—*India Rub. World*, 69:6, 2 pp.

Startling Results from Leather Research were reached by a large number of tests conducted by the Bureau of Standards. These tests have sought to determine the physical properties of leather, especially tearing strength and tensile strength, and much to the surprise of the committee as well as to leather men, it has developed that the first and second splits almost invariably are stronger and less easily torn than are the grain leathers now generally employed. It was reported also that at least one leather manufacturer has found it possible to so cure the first and second splits as to make them as soft and pliable as the grain leathers, which heretofore have been standard for upholstery purposes and have been more carefully treated because of the higher prices which they command. Another rather startling fact revealed in Mr. Herrmann's report was that it is possible to repair cuts and grub holes in upholstery leather in such a way that the repaired portion not only is stronger than the original part, but cannot be detected on the finished side even by men with long experience in judging leather qualities.—*Automotive Ind.*, 50:5, 1 p.

Supercharging.—The altitude flights of Lieutenant McCready with a supercharged Liberty engine have focused public attention on supercharging. Supercharging is simply the accomplishment of forcing more gasoline vapor into a cylinder than it could get through normal aspiration. This can be accomplished by true supercharging, which consists of forcing an additional charge of vapor into the cylinder at the end of the exhaust stroke, or during the compression stroke of the engine, through the medium of a pump or differential piston, or, by the more usual method of forced induction which uses a blower, driving air into the mouth of the carbureter, a means of driving the blower and suitable apparatus to compensate for the additional pressure at the mouth of the carbureter, in the float chamber and the gasoline pressure line.—*Rudder.*

Limousines Exeunt.—Sixteen importers, custom body builders and other producers of de luxe cars, fittings and accessories, exhibited at the annual Automobile Salon which was held simultaneously with the automobile show, at Chicago. If bodies at the salon suggest probable trends in closed car design, inside-drive jobs seem likely to replace the former type of limousine. Practically all the town car bodies shown were of the Berline type, with dropping glass partition between the driver and the passengers. In many of these bodies efforts have been made to have the glass partition drop entirely out of sight, instead of having part of the glass exposed when the window is down.—*Automotive Ind.*, 50:6, 3 pp., ill.

Progress Toward 1000 Horsepower Aircraft Engines is the subject of an interesting discussion of highpowered engines in *Aviation* (16:8, 3 pp., ill.) Numerous reports have come from abroad regarding the European development of large bombing engines, whereas very little information has been circulated concerning similar developments at home. As a matter of fact, our Air Service has been actively engaged in the design and development of large bombing engines ever since the war following the signing of the Armistice. Records show that so far only thirteen airplane engines rated not less than 600 h.p., have actually been designed and built. Seven are of French design, three are British, two are American, and one is Italian. As far as can be determined the U. S. Air Service was therefore without any reliable engine of over 400 h.p. at the end of the war. During the following year, designs were laid down for an eighteen-cylinder W type of 2778 cu. in. piston displacement known as the model W1. This engine is composed of three rows of six cylinders each, with an included angle of forty degrees between each of the outer rows and vertical row in the center. This arrangement of cylinders probably gives as compact an engine for the displacement as can be produced, besides having the features of perfect inertia balance, and good evenness of torque delivered to the propeller. The

(*Continued on page 342*)

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GENERAL ELECTRIC

Scientific American Digest

(*Continued from page 340*)

first one of these engines was completed near the end of 1920. The rated horsepower was 700 at 1700 r.p.m., and 750 at 1800 r.p.m., but the first dynamometer tests showed a much greater output. The original engine, except for the occasional substitution of a few new parts, completed five fifty-hour endurance tests, besides other tests which probably made a total of about 300 hrs. running. Never before has the first engine built from any design been known to have made such a record, nor has any engine of its class been known to complete tests of equal duration. The weight of the Model W1A engine is 1770 lbs. and, when set to give normally 800 h.p., represents 2.21 lb./h.p. This figure is lower than any of the six more or less successful large engines described above with the exception of the Rolls-Royce "Condor." Modifications, which are being tested from time to time, indicate that the weight of this engine can be reduced to less than 1500 lbs. without the slightest sacrifice in life and reliability. The weight per horsepower would then be 1.87 lb., the lowest value ever obtained for an engine of over 500 h.p., excluding of course flash readings taken on experimental engines and lower in fact than for the majority of smaller engines. The U. S. Army Air Service now possesses one of the best bombing engines yet developed, and the experience which indicates that successful engines of 1000 to 1500 h.p. can be built to weigh less than 1.5 lb. per h.p.

Air Cleaners.—If one can judge worth by increasing popularity, air cleaners have established for themselves a place in the sun, for they are now used as standard equipment on five makes of passenger car. This has been brought about in the face of opposition on the part of car makers to any increase in equipment the need for which is not abundantly proved. Rapid wear of pistons, rings and cylinders has been a normal condition in automotive engines for many years. Since dilution by fuel of crankcase oil has come to be pronounced, much of the wear has been laid to the resultant decrease in viscosity of the oil, but there is a growing belief that, except under extreme conditions, dilution alone is not so serious as has been thought. Dilution plus dirt, especially road dust containing abrasive material, undoubtedly results in rapid wear and there is not the least question that much dirt enters through the carbureter with the charge of air and fuel and is washed onto the bearing surfaces of rings, pistons and cylinders. So pronounced is its effect in the case of tractors, which often must operate in clouds of dust a large part of the time they are in use, that air cleaners are regarded as an absolute necessity. With passenger cars and trucks the effect is less only in degree, and since the number of hours' use per year generally is much greater than for most tractors, the rate of wear may be just as great. It is a well known fact that so-called "carbon" deposits in cylinders contain large percentages of silicon from dust inhaled by the engine. These deposits are said to be much decreased by the use of air cleaners.—*Automotive Ind.*

Making Solid Tires from Latex.—In this method, substances that combine with or absorb water, such as calcium sulphate (calcined gypsum) and other inorganic and organic colloids are added to the latex; these substances remain in the finished product, acting as fillers, and do not affect the elasticity of the final product. During overproduction and consequent cheapness of latex, this method is suitable for the manufacture of solid tires, which are fully as cheap as those hitherto made from rubber and are even more durable. The procedure described in the patent is as follows: The mixture of latex, calcium, sulfate, sulfur and other compounding ingredients is then made up, like a batch of concrete, and spread firmly on the rim between the plates. It is then well tamped, a solid rim is attached firmly around the running surface, and the latex mixture is allowed to set. To improve the strength, fibrous materials can also be included in the formula. After setting, the tire is vulcanized in the usual way; then the ring is taken off, the plates are removed and the tire is ready for use. The entire process is simple, it consists in a latex-cementing (or, better, a latex-gypsum) treatment of an iron or wood rim. The solid tire thus made, however, is more durable than those hitherto manufactured, because the latex is coagulated only once, direct to the finished tire, and hence retains all its life.—*Chem. and Metal. Eng.*

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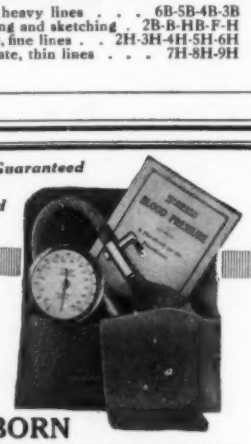

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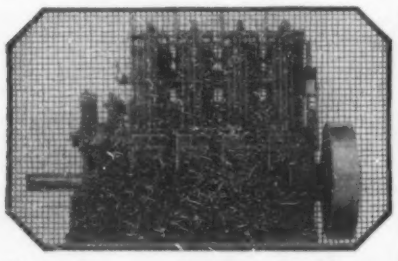

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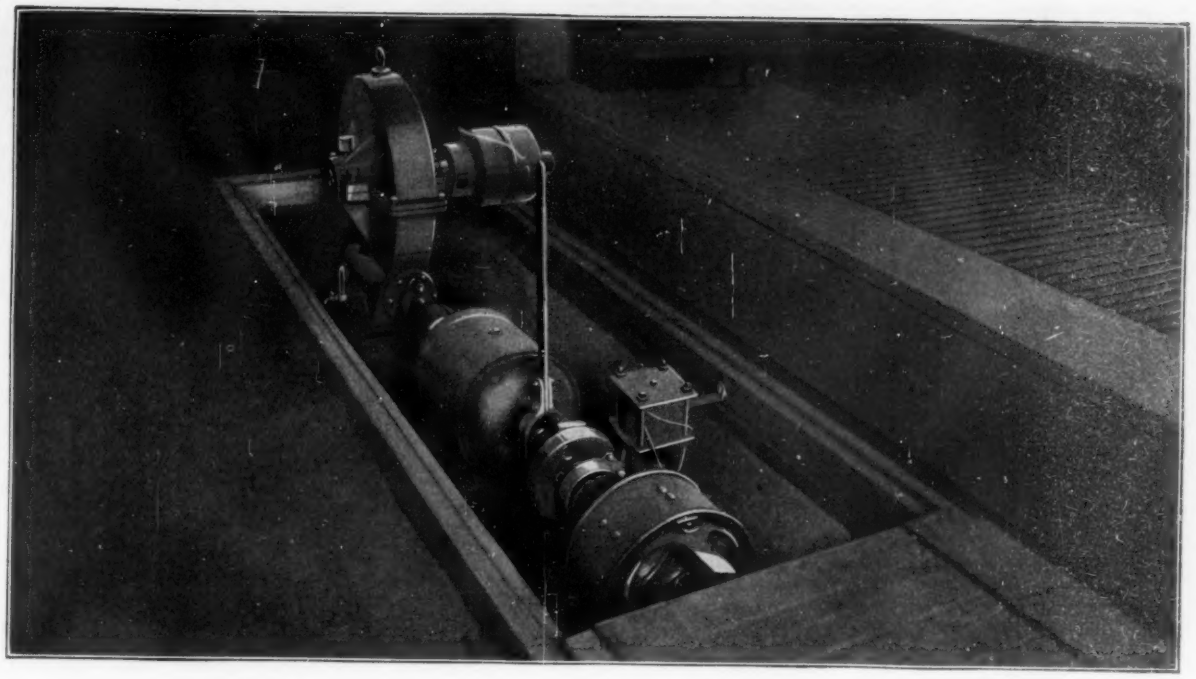
Civil Engineering

Why Italian Dam Failed.—On Dec. 1, 1923, a 143-ft. power dam at Gleno, Italy, failed suddenly. Great destruction was done by the escaping waters along the valley of the Dezzo River in the 12-mile length down to its junction with the Oglio River at Darfo. The Dezzo Valley is steep and narrow, and in places the flood wave reached a depth of 100 ft. The loss of life is estimated at 500. The dam, only recently completed, was a reinforced-concrete structure of multiple-arch type resting on a gravity base of stone masonry. It was 143 ft. high above the stream, 863 ft. long on top, and of curved ground plan, comprising a circular central portion about 250 ft. long and straight end portions, tangent to the central curve. The reservoir back of the dam was of about 4400 acre-ft., or 190,000,000 cu. ft. capacity. The location is high up in the mountains, the highest reservoir level being about 5200 ft. above sea level, while Darfo is at 820 ft. No precise statement of the conditions leading up to the break of the dam can be given before the official inquiry is completed. Certain facts are fairly well established, however. On the authority of a competent engineer of dams who visited the Gleno structure repeatedly, it may be stated that the work was badly executed. The masonry of the gravity base was laid up in lime mortar, of lime burned near the site by the builders and transported to the dam by cableway. The specifications called for cement mortar. The gravel aggregate used in the concrete was not washed, and the concrete in the structure was porous. The reinforcement of the buttresses was scrap netting used during the war for protection against hand grenades. This same engineer stated that during construction one of the arches leaked, where a centering timber that projected into the concrete had been cut off flush with the face of the work. The reinforced-concrete parts of the dam on either side of the masonry base were placed directly on the rock surface, without being trenched into the rock, leaving its end embedded in the concrete. Hand-mixed concrete was used, and the usual precaution of ramming it in the forms was omitted.—*Eng. News-Record* 92:5, 3 pp., ill.

Electrical

Ground Currents from electric hoisting equipment were the cause of a premature explosion during the sinking of a shaft in West Virginia, which nearly proved fatal to the workmen employed. Some of the men refused to work in the shaft unless steam was used in place of electricity for operating the hoist and pumps. This was practically out of the question, since the electric equipment had already been installed. It was decided, therefore, to make tests to determine the cause of the explosion and to decide upon the remedy. The system used for power was grounded on one side and supplied by a 1000-kw. rotary converter. While the switches were open, an electric blasting cap was connected between a pipe in the air line and the discharge line from the pumps. The instant a connection was made, the blasting cap detonated. It was evident that there was a sufficient difference of potential present in the various places selected to fire blasting caps connected in an ordinary circuit in the shaft. To equalize the voltage at various points around the surface and at the bottom of the shaft, the frames of all the machines on the surface and the pump at the bottom of the shaft were metallically interconnected with a heavy copper conductor and grounded. After this work was completed $25 was offered to some of the most intelligent workmen if they could fire an electric blasting cap by connecting it in any way that it would explode, without, of course, using a blasting machine or the power circuit. None of them was able to fire a cap in this way.—*Coal Age*, 25:7, 1 p., ill.

Shrink-fitting a Large Waterwheel by Induction was an interesting solution of the problem of expanding the bucket runner on a 9500 horsepower unit as described in *Elect. World*. The over-all diameter of the wheel was 7 ft. 4 in., the diameter of the wheel center 4 ft. 7 in. and the length of fit on the shaft 18 in., with step fit of bores 13.006 in. and 12.996 in. in the present runner. The new wheel was put in place on the shaft in the following manner: Using available bare stranded wire and insulating by means of sheet and tape asbestos wrapped thereon as required, there were 39 turns placed around the hub and 54 turns around the periphery. These windings were connected in series and supplied with 60-cycle



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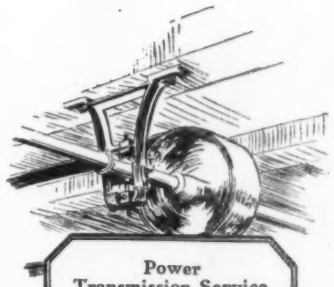

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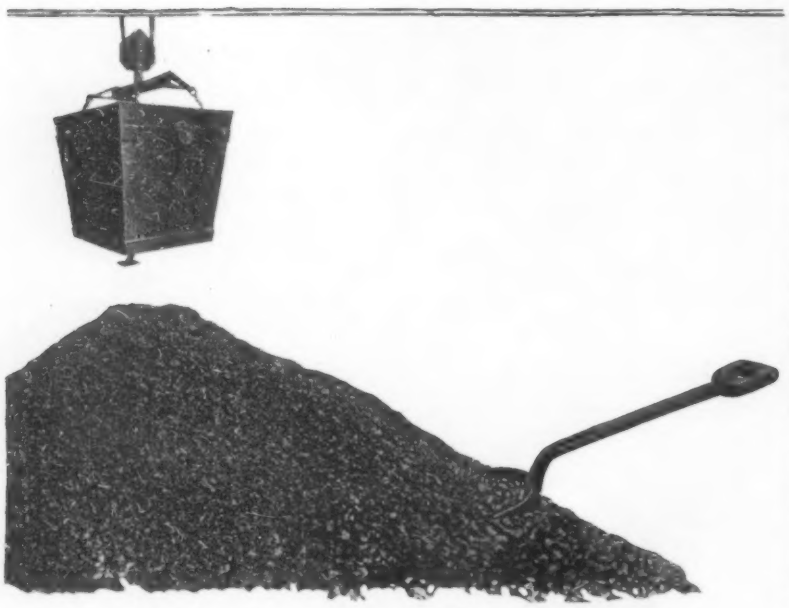

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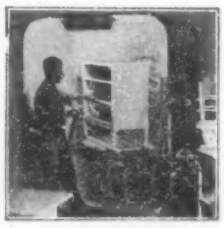

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alternating current through a regulating rheostat from a 37½-kva., 220-volt single-phase transformer. The potential across the coils was approximately 103 volts and the current varied from about 135 amp. to 150 amp. During the heating the wheel was suspended from the crane and was boxed in to assist in maintaining a uniform temperature throughout. Thermometers were placed so that the temperatures of the rim, hub, interior of the box and room could be observed. Upon applying the current it was seen that the hub temperature increased so much more rapidly than the rim temperature that it was advisable to bring up the temperature gradually by applying current for a few minutes at a time, allowing the heat to distribute within the box during the intervening few minutes. By this process the temperature of the wheel was raised gradually during a period of about 27 hours, when the box was removed from the wheel, leaving the current on until the wheel was in place on the hub. By means of this heating the inside diameter of the hub was increased 0.015 in. At the same time the shaft was inclosed with a box packed with ice between the bearing and the wheel location, resulting in a reduction in its diameter of about 0.001 in. The wheel was readily pulled into place with two rope tackle blocks one on each side, moving the crane meanwhile. The current was then cut off and the wheel allowed to cool.

Transmission Line Work Aided by Aerial Survey is the subject of a description of a new use for the airplane, contained in *Eng. News-Record* (92:9, 4 pp., ill.) Aerial photography was employed to facilitate the rapid completion of two high-tension transmission lines, 25 and 30 miles in length, respectively, in the southeastern corner of Pennsylvania. The photography for the lines under discussion consisted of contact lines and complete strip maps, with special stereoscopic views taken of some of the towns and of some properties to assist in obtaining right-of-way privileges. The average flying elevation was 12,000 ft. and the maps were finished on the scale of 1000 ft. to the inch. A single photograph showed a ground area of about one and one-half by two miles. There were in the neighborhood of 500 single photographs taken for the line strips. A standard biplane driven by a 150-h.p. motor and capable in calm air of a 6-hour flight at 60 miles an hour was employed in the flying. It was equipped with an observer's cockpit in the floor of which an opening was provided for sighting the camera. The camera made a picture about 7 by 9½ in. in size and used a roll film containing about 100 exposures. This brings us down to the point where use of the aerial photographic data actually began. The contact prints were studied in connection with the quadrangle maps and a line location laid out on the prints according to the most desirable possibilities of avoiding obstructions, high-priced land, and construction difficulties; also with the idea of accessibility during construction and for future maintenance. The prints were then put in the hands of the men securing right-of-way options. With their help the right-of-way agents located themselves at once on the proposed route and after a little inquiry determined the names of the property owners, which were given to the men making searches for descriptions of properties. As fast as descriptions were obtained from the county records the property outlines and owners' names were inked on the prints. When surveying parties were sent out to establish the final alignment and to determine the profile of the route they carried into the field the mosaics with the line route and property lines marked on them, and used them throughout the survey.

Industrial Progress

A New Casting Process is described in *Automotive Ind.* (50:5, ½ p.) By this process, iron castings are molded and poured with the expenditure of about one-eighth of the man-hours required by the sand-casting methods. In addition to this feature the surface hardness which is always present in sand-molded castings is absent in the permanent-molded castings. The iron is much closer grained, soft and easily machinable and uniform throughout. The process, which was discussed in *Automotive Industries* of November 1, involves a turntable which carries twelve permanent split-type molds. The molds are cast iron, being treated when cast so that the interior surfaces are highly refractory. In operation, the working surface of the molds are first

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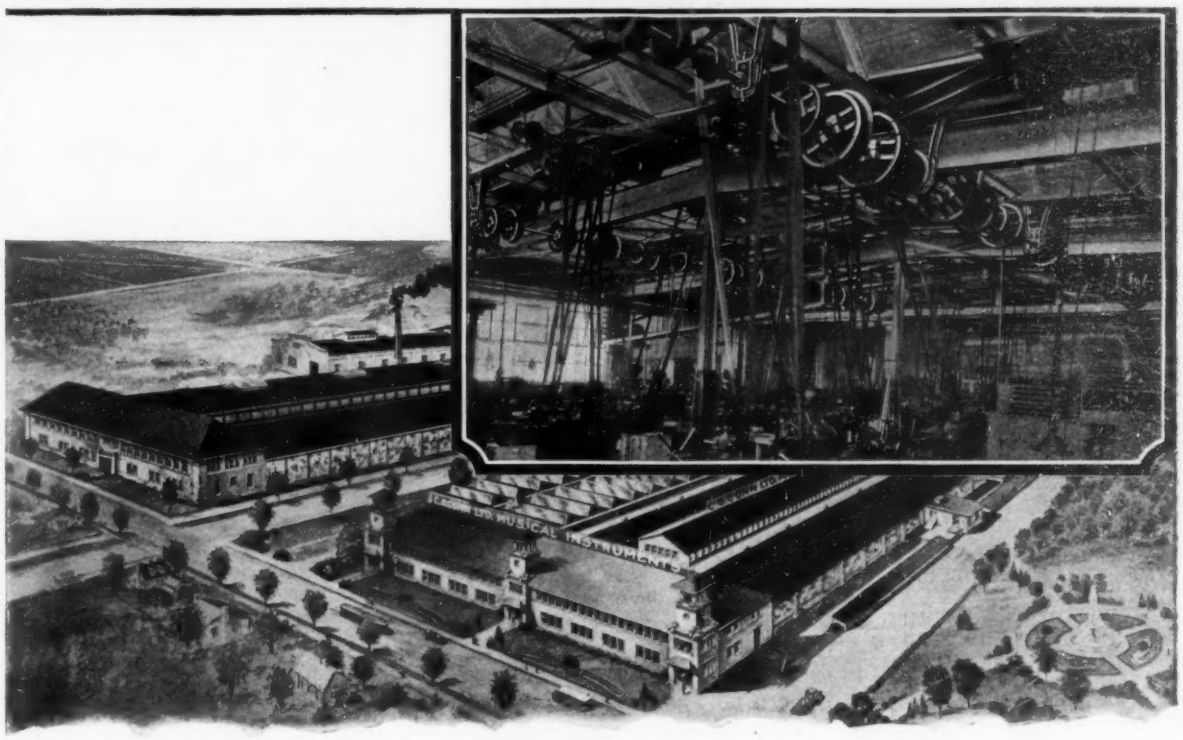
"STANDARD THE WORLD OVER"

coated with amorphous carbon by an acetylene flame. At the next station the dry sand core is set in one half. The mold then closes and continues around to the pouring station, where one man pours the iron from a small ladle. Next the mold opens automatically, the casting is knocked out and the mold is blown out by an air stream, ready for the repetition of the cycle. High silicon iron is used and the carbon coating in the interior of the mold reduces the melting point and retards the cooling rate so that the casting forms before the contraction of cooling takes place. The rate and total amount of construction is only about one-fifth of that of the sand casting process. As the surface of the mold is highly refractory and coated with carbon, the heat of the incoming metal is conserved and not lost to the mold, which condition causes surface chilling and slower flow. This process is now in operation on Holley carbureter bodies and Ford pistons. About 2500 pistons are produced per day per machine. Experiments have been made with the pouring of malleable iron and several non-ferrous metals with very good success. Steel castings can be made by this method providing complicated castings have some cores. The process is not limited to operations on small castings but is even better suited to the production of large castings. Iron castings weighing about 25 lbs. have been produced with every degree of success.

Modern Trend in Building Cement Mills.—A development of recent years in the manufacture of Portland cement has been the increasing use of large crushing plants for the preliminary reduction of the rock. There has been much recent discussion in regard to the relative merits of the wet process and the dry process of cement manufacture. Unmistakably the trend during the past five years has been toward the wet process. During this time, of 19 plants in the United States constructed or for which machinery contracts have been placed, 17 were designed to operate by the wet process. Of the two remaining, one, while a new plant, is an addition to an existing dry process plant. Of several new plants contemplated, all or nearly all are to operate by the wet process. Most modern plants have installed kilns from 10 feet to 11 feet in diameter. Two plants in the United States have successfully operated kilns 12 feet in diameter for several years. The limit of the kiln diameter, however, seems to have been reached until a better refractory or an improved method of holding lining is obtained. Until the introduction of waste heat boilers, the tendency was toward longer kilns; but since low temperature kiln gases make the cost of boilers high in proportion to steam produced, the recent practice has been to limit the length from 150 to 175 feet when boilers are used. Some wet process plants have installed kilns 240 ft. long, but no practicable length of kiln will reduce the gases to so low a temperature as a waste heat boiler and economizer. While there have been many important improvements during the past ten years, which permit the sale of Portland cement at a relatively lower advance in price than almost any other material used in construction, it is probable that the next ten years will see equal improvements. These improvements will probably consist largely of more efficient grinding, better economy in fuel consumption, more economical use of waste heat and reduced labor charges.—*Cement and Eng. News*, 36:2, 3 pp., ill.

The Concrete Stave is a comparatively youthful member of the building unit family. Invented less than 20 years ago, its use has been extended to practically every state and community in the country. Soon afterward concrete staves were used in silo construction, their shape making them especially suitable for circular structures. Today, concrete staves are also used in the construction of grain bins, coal pockets, barns, hog houses, garages and other buildings. Their most extensive use, however, is in the construction of silos and coal pockets. In general, the concrete stave is a concrete slab about 30 inches long, 10 inches wide and 2½ inches thick. The average weight is around 70 pounds. There is some variation in width and length among the different types of staves that have been developed. Practically all types are of the same thickness. Since the staves are rather large and are set up without mortar, rapid speed of construction is possible. A 100 ton silo can ordinarily be completed by three men in two and one-half days' time. This is much quicker than for any other type of

IN THE PLANT OF C. G. CONN LTD. ELKHART, IND.



Dodge Transmits Power to Build Instruments for the Masters

From a tiny workshop, employing one crude lathe improvised from a sewing machine, through three devastating fires, C. G. Conn, Ltd., has grown to the large plant shown above manufacturing band and orchestra instruments. 180,000 feet of floor space is overhung with Dodge Power Transmitting Machinery, including pulleys, hangers clutches, etc.

Conn specifies Dodge Power Transmitting Equipment because Dodge represents to Conn what Conn represents to the master musician.

Dodge means power savings. Three large factory warehouses and fourteen branch warehouses supply 500 local dealers who supply Dodge power transmitting appliances on the immediate delivery basis.

Dodge Units Withstand Fire and Water

Some of the Dodge equipment in use today in the Conn factories went through at least one of the devastating fires which reduced three Conn plants to ruins. Salvaged from the ruins, Dodge hangers, pulleys and shafting were again pressed into service, while Dodge engineers worked tirelessly to assist in re-establishing production schedules.

DODGE

DODGE MANUFACTURING CORPORATION *General Offices:* Mishawaka, Indiana *Works:* Mishawaka, Ind., and Oneida, N. Y.

EVERYTHING FOR THE MECHANICAL TRANSMISSION OF Power

Branches: New York Philadelphia Pittsburgh Boston Cincinnati Newark Chicago Atlanta Minneapolis St. Louis Houston Seattle San Francisco

When Production Must Be Increased

When the Board of Directors authorizes immediate extension of facilities to increase production the executives responsible for the execution of the plans are faced immediately with many problems. Orders for machinery must be placed, the power plant must be re-arranged, the power roadbed or transmitting system must be expanded. Delivery is all important.

The increased power demands may mean many things. New flywheels, rope sheaves, hundreds of hangers, pulleys, couplings, collars and couplings. Centralization of purchases means time saving andeconomy. The manufacturers possessing facilities for supplying all stock appliances such as pulleys, hangers, etc., as well as special built-to-order flywheels and special equipment other than power transmitting equipment is in an enviable position to serve when prompt execution of increased production programs is imperative.

The Dodge Manufacturing Corporation has sustained their reputation for rendering emergency service to industry for over forty years.

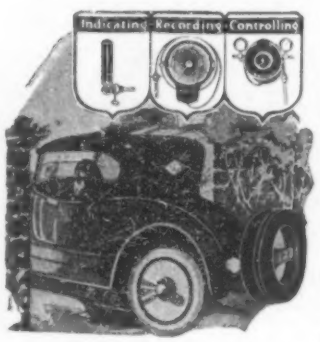
Extensive engineering, foundry and machine shop facilities are at the immediate command of manufacturers for the production of large flywheels up to 50 tons, huge pillow blocks, special bearings and built-to-order power transmitting equipment. In the Dodge shops thousands of tons of equipment, such as complete piercing mills, plate glass polishing tables, etc., are produced yearly.

Facilities for the design and manufacture of agitators, cement mill machinery, crushers, oil mill and oil well equipment, rubber mill machinery, etc., are available.

In addition, and of prime importance to the executive faced with the problem of securing almost immediate delivery of large quantities of stock power transmitting units, is the three large factory stocks, five hundred local dealer stocks and fourteen branch warehouses placed at strategic points throughout the country ready to ship pulleys, hangers, pillow blocks, couplings, clutches, etc., at a moment's notice.

In Chicago a stone's throw from the Chicago Junction Railroad Freight Station, is a large factory stock of Dodge products available for shipment by package car. Over 2,500 of these cars leave Chicago daily over 39 railroads.

Dodge facilities for manufacture and immediate delivery have kept pace with industrial progress and will always maintain a position of leadership in the important business of aiding industrial expansion.



That week end trip

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Tycos

YOU didn't necessarily consult your thermometer or stormoguide before starting—but your car itself couldn't have been made by luck and guess.

From the engine to the tires, from the smallest switch to the chassis and body, even the enamel and windshield, all are the result of Temperature, *properly controlled.* Just as carefully as a doctor watches his patient's temperature in a critical case—does the modern manufacturer watch his product in the making.

For three-quarters of a century more scientific instruments for recording, indicating and controlling temperature have been made in this country by the *Taylor Instrument Companies* than by all other manufacturers together. In many establishments can be found *Tycos* instruments with a longer record of dependable service than any other employee.

And in the home the Stormoguide told the weather forecast, so the family were equipped for the occasion.

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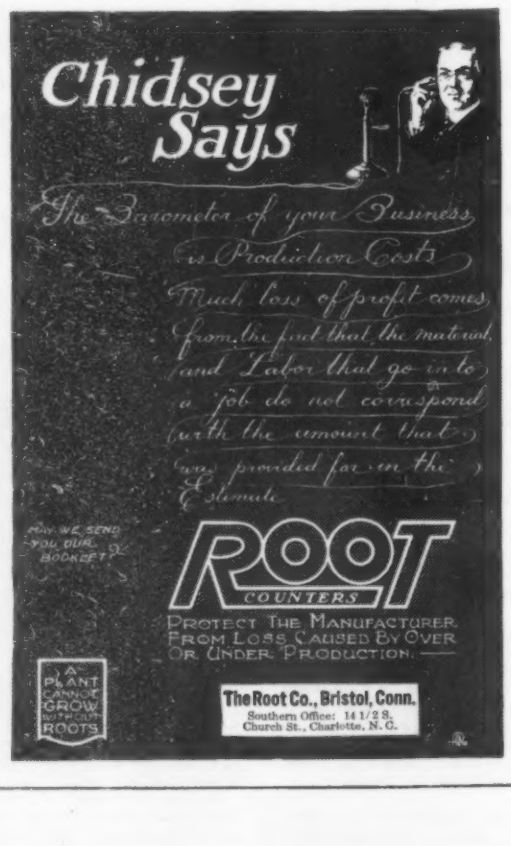


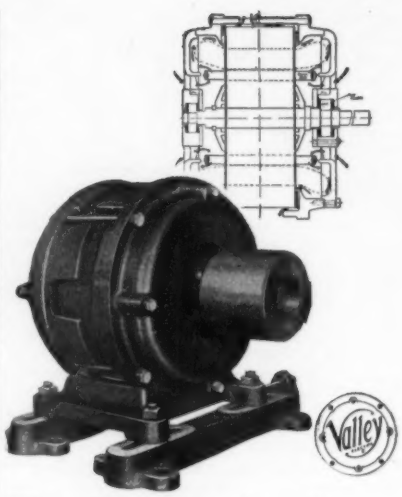
masonry silo. The necessary skill required to set up the staves is easily and quickly acquired by the average man with some mechanical ability. Soon after the advent of the silo type of coal pocket, these structures were built of concrete staves. Coal pockets are almost identical in construction to silos except that they are usually larger and are more heavily reinforced to resist the greater pressure of coal.—*Cement and Eng. News*, 36:2, 4 pp., ill.

The Federal Specifications Board has completed the second year of its activity. In this, the American Engineering Standards Committee has co-operated by obtaining criticisms from the various interested industries of proposed specifications of the Federal Government before the specifications are finally adopted by the board. To date the board has adopted approximately 90 specifications, and the committee has secured criticism of industry on about the same number. From these systematic efforts to bring governmental purchases in line with the best commercial practice, important economies both to industry and government are resulting.—*Am. Gas Jour.*

Mechanical Engineering

A New Non-torsional Spring.—In springs of all usual designs, the material is subjected to bending or torsion and their capacity is limited to their volume. Any increase in their capacity to absorb energy can be obtained only by means of a corresponding increase in volume, which is, however, frequently impossible due to lack of available space. A change in the nature of the stresses to which the material is subjected is frequently the only way whereby such an increase in capacity can be obtained. Due to the fact that pure tension and compression stresses lead to a far more complete utilization of the material, spring experts have for a long time been trying to design a spring in which only such stresses occur. These efforts have finally led to the invention of the ring spring, the first design in which all parts are uniformly subjected to tension or compression stresses. The spring consists of inner and outer solid rings which fit into each other along conical surfaces. When axial pressure is applied the outer rings are subjected to tensile stresses and the inner rings to compression stresses, always within the elastic limit of the material. On account of the deformation of the rings which occurs, they slip into each other and a spring action in the direction of the longitudinal axis of the spring is obtained. An important feature is that the relative motion of the rings is also opposed by a considerable friction between the conical surfaces, which materially increases the spring reaction during compression and exerts a retarding action during the recoil at release. This property is of particular value in all devices where a great amount of energy must be accumulated and, as far as possible, consumed.—*Am. Machinist*, 60:7, 2 pp., ill.

What is the Water Circulation in a Boiler?—Ask yourself this question and see how near your answer approaches the real facts as here outlined. The wide divergence in opinion as well as the lack of actual information possessed by even those conceded to be the "knowing ones" in boiler design, was strikingly brought out in a contest. Under the terms of the contest the engineer who described correctly the circulation in the horizontal return-tubular boiler was to be awarded a prize. Hundreds of engineers and engineering associations entered the contest, and the variety in answers almost equalled the number of contestants. A local of the National Association of Stationary Engineers won the prize, the answer, which was a composite of its members' opinions, being practically correct. Incidentally, some of the members actually constructed a glass model of the boiler before submitting their answer, and so were playing a "sure shot." Examination of the glass model shows that the water and steam mixture rises up along the front head at a high velocity, and after releasing the steam bubbles, the water moves toward the rear until it reaches a point a little beyond the center of the boiler, whereupon it drops downward. Upon reaching the lower part of the boiler, the main part of the stream turns toward the boiler front, while a part flows toward the rear. There is a secondary steaming zone at the rear head, causing an upward flow, the current then flowing toward the front and downward, making a loop. These two actions cause the circulation of the water to be in the form of a figure 8 placed horizontally.—*Power*, 59:8, 2 pp., ill.



"Best Ventilated . . ." —and why he said it

That's what the manager of a big motor repair shop said about Valley Motors.

This ventilation is gained by the extension of the copper rotor bars on both sides of the rotor. Air is drawn into the motor through the end plates by the extended rotor bars which act as fans. The cooling air currents are forced over the winding and stator laminations and driven out through vents in the frame.

Good ventilation means low temperature rise. And low temperature rise in a motor prolongs life.

Valley polyphase motors are made in sizes from ¼ to 40 h. p. Valley single phase motors are made in sizes from ⅙ to 5 h. p.

Write for Bulletin No. 8-22. It describes all details of Valley design and construction.

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Representatives in Principal Cities

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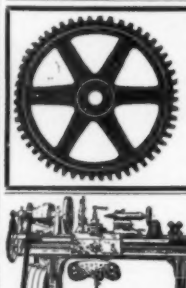

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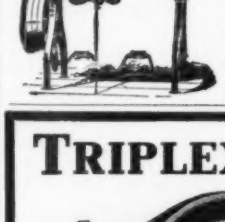

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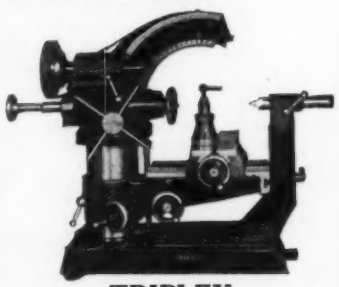

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General

Zirconium has an exceptionally high melting point, above 4000 degrees Fahrenheit, and it is not attacked by the strongest acids. The perfection of zirconium steel has not yet been reached, but the highest quality of zirconium tool alloy is in daily use in this and other countries. In the manufacture of white sanitary ware, bathtubs, toilets, cooking utensils, hospital ware, washstands, in fact, in every known form of white enamel ware, zirconium is now being used as the material that gives the white color and glaze which resists the action of acids, of disease germs, and the corrosion of decaying matter. In making electric porcelains zircon is one of the best materials. In airplane and automobile spark plugs, wireless telegraph insulators, high-tension transmission insulators, and for similar uses, it is of the greatest value. It plays an important part wherever either high temperature or high voltages, or both, have to be withstood. These qualities also make it desirable as a refractory, in fire-brick furnace-linings, retorts, crucibles, and ladles.—*Mfr's. Record*, 85:8, 5 pp., ill.

Hugo Stinnes, the German Industrial Baron.—The concentration of German industry goes on. A few weeks ago a new German oil trust was promoted by Hugo Stinnes. He combined three important petroleum producers of Germany under his direction: The Riebeck'sche Montanwerke, the Aktiengesellschaft für Seeschiffahrt und Ueberseehandel, and the Aktiengesellschaft für Petroleumindustrie (Api). The Riebeck'sche Montanwerke are important producers of mineral oils and paraffin from bituminous lignites. In 1921-22 this company produced 26,600 metric tons of mineral oils, and 9700 metric tons of candles, paraffin, and mineral wax. The output of lignite amounted to 6,300,000 metric tons; of tar to 34,273 metric tons. The Api was founded in 1896. It owns the famous Bergin patents, methods which make it possible to liquefy coals into oils. For this purpose a modern plant with a capacity of 100,000 metric tons yearly was built near Heidelberg. The company controls also a great number of refineries, storage plants, and oil fields in Hanover. The Aktiengesellschaft für Seeschiffahrt in Hamburg possesses tankships, storage, and distribution plants, oil fields in Argentina, and controls a number of trading companies. Thus this new trust combines the production of coal, lignite, oil, and the refining and distribution of its own and other products.—*Eng. and Min. Journal Press.*

Benefits of Moral Support and Capital in Research.—The economies that have resulted from the introduction of the new copper-silicon anodes at Chuquicamata, Chile, are such that it may be said that the first phase in the development of that gigantic enterprise has been passed—the perfection of cheap and efficient technical methods for the extraction and recovery of the copper. The history of the Chile Copper Co. provides many lessons of deep significance to the capitalist, as well as to the non-technical observer. It shows that the essentials needed for successful achievement comprise unhampered research, adequate capital, and moral support. It is interesting to note that improvements in technology and economies of operation have been steady but by no means rapid. In 1915 the plant operated for seven and one-half months, and 625,394 tons of ore was treated, with an extraction of only 66.87 per cent. In 1916, 1,742,748 tons was treated, with an extraction of only 77.15 per cent; and it was not until about 18,000,000 tons had been treated and an experience extending over five years or so had been gained that an extraction of 90 per cent was achieved. One wonders what would have happened to the Chuquicamata process if it had not been backed by the availability and influence of ample capital; if those who were responsible for the inception of the plan had been systematically balked in their demands for adequate research; and if enthusiasm had been dampened at the outset and capital diverted in other direction by a verdict based entirely on the opinions of those who were sceptical of ultimate success, or envious of initiative, or both—a verdict that took account of nothing more than the poor metallurgical showing and the comparatively high cost of production at the outset of operations.—*Editorial in Eng. and Min. Jour.-Press.*

How Much Ash Is Found in Commercial Anthracite?—During the past summer the U. S. Bureau of Mines took 127 samples of anthracite, each of 1000 pounds, representing nearly 30,000 tons of such coal

Electric motor users find distinct advantages in motors equipped with Strom Ball Bearings

Double-acting thrust bearing, flat seats (grooved races) 2100-F Series

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Uninterrupted service of electric motors is insured by elimination of insulation troubles caused by oil leakage.

Housings are designed for the retention of lubricant, thus preventing its escape and entrance on to the insulation.

Motors require only a small amount of lubricant.

There is a marked reduction of friction, thereby reducing starting and running resistance. In fact, the starting resistance is no greater than the running resistance.

Maintenance and service costs are lowered.

A uniform air gap between armature and coils is maintained, because the wear of ball bearings is negligible.

More compact motor design is permitted because of small bearing width space required.

End motion of rotor in the field is eliminated, because STROM Ball Bearings take end thrust as well as radial load.

Single-row deep-groove Standard type, radial bearing

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Angular contact bearing, combination radial and thrust

Double-row, maximum type, radial bearing

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STROM Ball Bearings are made in a wide range of types and sizes for practically any installation in automotive and machinery fields. Our engineers will be glad to assist in the selection of bearings and in the design of their mountings.

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From the Vice-President of one of America's great copper concerns. Name and address on request.

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The car that is equipped with Hoo-Dyes is a *safe* car. It is safe because the double-acting, hydraulic shock absorber prevents pitch and side-sway; it is safe because all four wheels are held on the ground no matter how great the speed; it tends to prevent skidding on rough roads even if the brakes are applied for an emergency stop. The Hoo-Dye hydraulic control, which transmits every axle movement directly to the liquid cushions by means of a drop-forged, double-acting connecting-rod, brings to motorists a marvelous *sense of security* combined with *supreme riding comfort.*

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Double-Acting Hydraulic Shock Absorber

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FORMICA in electrical and mechanical applications is serving many purposes better than was possible until just recently.

It combines the highest dielectric strength with high tensile strength; it has a low phase angle and extremely low power and hysteresis losses in high frequency work; it does not absorb moisture and is not affected by oil or chemicals of any kind; it will not warp, sag or cold flow, nor change its color. It is used for silent elastic gears in automobile timing trains, and for industrial purposes. Its strength is similar to cast iron, but its wearing qualities are greater.

As radio and electric insulation, for pump valves, gears, washers' bushings of all kinds its use is expanding at an amazing rate.

Perhaps it will solve a difficult material problem for you. Write for booklet "What Formica Is."

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in dealers' yards in seventeen cities in the State of Massachusetts. There were three objects in view: To discover the average and the variation in the quantity of ash in anthracite in some easily described area; to demonstrate standard sampling methods and to learn something about the feasibility of itinerant coal sampling. The weighted average ash content was: For furnace size, 13.2 per cent; egg, 13.7; stove, 13.7; chestnut, 16.2; pea, 15.6; range, 19; buckwheat No. 1, 18.9 per cent. In the eight samples of furnace coal the lowest ash was 10.5 per cent and the highest 14.6 per cent; of 29 samples of egg the range was from 10.2 to 17.5 per cent; of 20 samples of stove coal, 11.3 to 15.9 per cent; of 23 samples of chestnut, 10.3 to 46.1 per cent; of 20 samples of pea, 12 to 27.3 per cent; of four samples of range, 13.1 to 28 per cent; of eight samples of No. 1 buckwheat, from 13.6 to 29.5 per cent. In the chestnut coal the highest six samples ran 46.1, 40.7, 28.3, 25.6, 18 and 16.5 per cent ash. The six cleanest samples ran 10.3, 12.2, 12.9, 13, 13.2 and 13.4 per cent ash. The coal producer judges the quality of the coal by taking a small sample and by hand separating it into three piles, one of coal, one of bone and one of slate. A piece which he guesses has less than 40 per cent ash would be called coal, a piece having from 40 to 65 per cent ash would be called bone, and anything having a larger amount of unburnable material would be called slate. The figures obtained by this survey give an idea of the actual quantity of ash in anthracite sent to one district in the summer of 1923, when the opinion of dealers was that the quality of the coal in general was good.—*Coal Age*, 25:8, 1 p.

Another Attack on the Cotton Boll Weevil has been made by a Georgia grower. By increasing the thickness of the hull of the cotton boll through a process of breeding extending over ten years, J. V. Cochran, of Marietta, Georgia, has produced a cotton that practically defies the boll weevil. With this cotton, the use of poison has been found necessary only while the stalks are young. After the bolls have developed, the yield is assured without the further use of poison, for the thickness of the hull furnishes full protection to the precious staple inside. The idea that the hull of the cotton boll could be made so thick that it could not be penetrated by the boll weevil came to Mr. Cochran about ten years ago when he read of the ravages of the pest in the States to the west and realized that it was only a matter of years when the Georgia farmers would be faced by the weevil problem. Setting himself to the task of producing a thick bolled cotton, he selected three varieties with which he was familiar and planted some of the seed. Calcium arsenate was used by Mr. Cochran while his cotton was small, giving the bolls an opportunity to obtain their growth, and then discontinued. Other cotton, however, was practically a total loss when the use of the poison was discontinued at the same time. Practically every green boll in the field was literally peppered with holes around the stem—the bolls were the only thing in the field that remained green at the time—but when a boll was cut open it was found that, with rare exceptions, the cotton was undamaged. Most of the bolls, however, opened perfectly, even though they were perforated at the base all around the stem. The weevil had done its best to get through to the lint inside, and failed.—*Mfr's. Record*, 85:7, 1 p. ill.

Will Faster Flying Be Dangerous?—Yes, says Major L. H. Bauer, Commandant, the School of Aviation Medicine in *Aviation* (16:7, 2 pp.). In making turns, centrifugal force hurls the blood from the brain. He also changes the flier's body from vertical to horizontal. Continues the author, "Have you ever jumped quickly out of bed and felt dizzy, everything in front of your eyes becoming blurred? If so, your circulation, which was adjusted to the horizontal position in bed, did not adjust itself quickly enough to the upright position. As a result you had insufficient blood in your brain causing temporary dizziness and faintness. This will give you perhaps some idea of how a racing pilot feels as he turns the pylons. Centrifugal force pulls on his body and as a result everything in his body that can move does so in the direction of the pull. This means that his blood, which is, of course, fluid, is carried away from his head into the easily enlarged splanchnic vessels, and even into his legs. This means that he has a lack of blood in his brain or what medical men call anemia. When we have anemia of the brain we become unconscious. Hence, a flier may become unconscious when making a turn at terrific speed. When a man is flying at the rate of four miles per minute, it will be seen that making a turn occupies but a moment. Anemia of the brain causes faintness and unconsciousness immediately. The flier quickly recovers because the circulation rapidly adjusts itself to the new position of the body and the action of the centrifugal force quickly changes to the direction of the new line of travel. Is it possible to maintain a speed so great that the anemia produced will be so marked and so prolonged that recovery will not take place? The answer is probably yes. We cannot say how great this speed will be. Experience only will show. However, we have another factor, not yet mentioned, on which we shall have to figure. Dr. Garsaux of France made some experiments with dogs. He rotated them on a wheel at speeds varying from four to six turns per second. Some of the dogs showed actual injury to the brain from the brain being pressed against the skull. Recovery followed in some, death in others. Autopsies showed that there was an anemia of the brain, and an engorgement of the vessels of the abdominal area, thus bearing out our statements about the aviator. It is therefore not a wild theory to presume that a speed may yet be attained which when a turn is made would be sufficient to cause pressure on the stem of the brain in such a manner as to cause death. Furthermore, the force of such violent action would be sufficient to rupture blood vessels both in the brain and in other parts of the body, which in themselves might be sufficient to cause death or lasting injury.

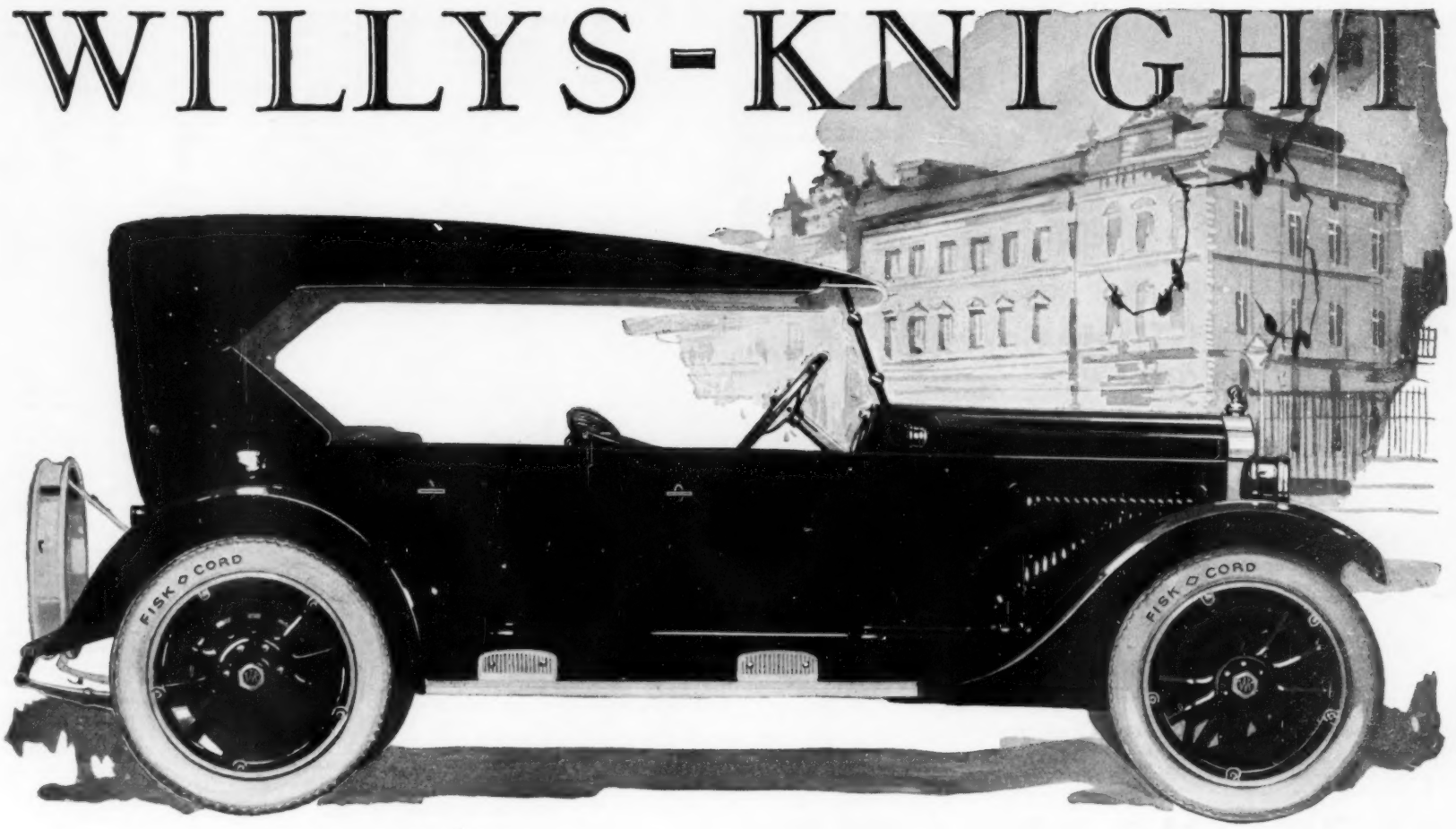
Metallurgy

The Alloy Burrowlite is made from nickelferous ore obtained in the Sudbury district of Ontario. In the smelting process the ore is crushed and then treated in a revolving cylinder from which oxygen is excluded and into which a gas containing 89 per cent hydrogen and 10 per cent nitrogen is introduced. The ore then is smelted in a crucible or other suitable furnace and scattered on the floor. After 24 hours' exposure to the air the product disintegrates into a purple colored powder which is further refined and cast into pig form. The smelting process requires about four days. Properties imparted to steel by the addition of the alloy include toughness, great density, a high elastic limit and ultimate tensile strength, either high or low longation as desired, and machinability even when showing a brinell hardness of 360 or more.—*Iron Trade Rev.*

Alloying Nickel with Cast Iron.—Cast iron is emancipating itself from its accepted role of poor cousin to steel, and much more care and attention, and what is more significant, expense, is devoted to its manufacture. The effect of nickel on iron depends upon the presence and amounts of other elements, upon the form of the carbon and other factors. The presence of nickel in cast iron causes increased graphitic carbon formation; i. e., nickel tends, as does silicon, to gray the iron. This effect is quite definite but fairly mild; 1 per cent of nickel being equal perhaps roughly to from ¼ to 1 per cent of silicon in this respect. The nickel does not form carbides, but dissolves in the ferrite of the iron. If the composition is such that combined carbon is present in the castings, this will be fine in structure in the presence of from 1 to 5 per cent nickel, and more resembling sorbite than pearlite, and in consequence harder. Therefore, it will be seen that nickel exercises two effects quite opposite in nature, by lowering the combined carbon it softens the iron, but by sorbitizing the pearlite matrix of the iron, it hardens it. Which of these will prevail depends largely on the amount of combined carbon. If this is low in the composition of iron under consideration; i. e., if the iron is soft and open the nickel will soften it still further. If it is high, from 0.3 to 0.8 per cent, the hardening effect will predominate, as in fact it generally does in practice. Grades of gray iron carrying from 0.50 to 0.85 per cent of combined carbon in general will be hardened, strengthened and toughened by the addition of from 1 to 5 per cent of nickel. Increases of from 15 to 40 per cent in hardness and in bending or compressive strength are thus obtained. The use of nickel often is beneficial, particularly in thin sections, in that good values of hardness may be obtained without incurring the risk of obtaining chilled or mottled iron or hard spots. The hardness obtained in gray iron by nickel additions is not due to an increase in the amount of carbide present, as it is when

(*Continued on page 350*)

WILLYS-KNIGHT



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Commercial

ANNULAR BALL BEARINGS

Scientific American Digest

(*Continued from page 348*)

obtained by lowering the silicon content, with consequent attendant machining difficulties, but is due to the superior and finer form of the pearlite or carbide in the presence of nickel.—*Iron Trade Rev.* 74:8, 2 pp.

Permalloy has such remarkable magnetic qualities that its use in the manufacture of submarine cables will permit messages to be transmitted at speeds many times that now obtainable, and that is only one of the many applications that this new alloy is sure to find. Permalloy is an alloy of nickel and iron characterized by extremely high magnetic permeability at low magnetizing forces. Its extraordinary "magnetic permeability" means the ease with which magnetic "lines of force" penetrate it and make of it an electro-magnet. It is far the most easily magnetized and demagnetized of all metals now known. The particular composition which is best in this regard contains about 80 per cent nickel and 20 per cent iron. The mere mixture of the two metals is, however, not sufficient to secure the highest permeability. A special heat treatment is also required. When properly heat treated its initial permeability is more than thirty times that of soft iron. Another interesting property of nickel-iron alloys of about this composition is extreme sensitiveness of magnetic properties to mechanical strain. So far as has been determined, however, it is only in connection with its magnetic properties that permalloy is unusual. The X-ray study of these alloys reveals that their crystal structure is like that of nickel. Permalloy can easily be cast in ingots, reduced to billets, drawn into rods and wire, and rolled to thin tape. To the engineer the discovery of permalloy will mean the accomplishment of results heretofore believed impossible. For the scientist the principal interest in these high nickel-iron alloys may well lie in the large response of their magnetic properties to simple external controls. Without alteration of composition these properties may be adjusted through extraordinary ranges by strains, by magnetization, or by heat treatment. This allows a more definite study of the way in which these factors are related to magnetic properties than has been possible with materials hitherto available in which their effects are comparatively small and may be associated with complicated and irreversible changes in other properties.—*Can. Min. Jour.*

Desulfurization of Coke by Steam, the subject of experimental work conducted by the Department of the Interior and the Carnegie Institute of Technology at the Pittsburgh Experiment Station of the Bureau of Mines, has demonstrated that the steaming process effects a greater sulfur removal than is possible with other processes. The economic importance of the results of these experiments is that they point the way to future utilization of enormous reserves of high-sulfur coals not now suitable for coke making. At the present time only low-sulfur coals are used for this purpose. Sulfur in metallurgical coke gives rise to many problems and difficulties in furnace operations. Over 1¼ per cent of sulfur is likely to produce an inferior grade of iron. Sulfur will, in addition to causing trouble in the furnace, make it difficult, if not impossible, to work the iron. Any process for removing this deleterious substance from the coke is therefore of value to both the manufacturer and consumer of coke, if the cost is not prohibitive. In addition to solving one of the principal problems of the steel industry, this removal would create a much greater coal supply from which the coke producer would draw his raw material. Many of the coals of Pennsylvania, West Virginia and Kentucky are so high in sulfur that their use for the manufacture of metallurgical coke is prohibitive, without preliminary treatment by the present known means of coal cleaning, principally coal-washing, which is not always an effective remedy. Illinois has the greatest potential coal supply of any State in the Union, with the possible exception of Wyoming, which is underlain by immense fields of low-grade subbituminous coal. Nearly all of this Illinois coal will make good coke, if not alone, when used in proper mixtures with other coals; but in most cases the sulfur content is above the limit fixed by present standards. Many processes have been tried for the removal of sulfur from coke, including steam; but most of them have not met with any degree of success. The investigators at the Bureau of Mines laboratories found that between 10 and 15 per cent of the total sulfur in the coke is removed by simple steaming at 750 degrees C. With alternate vacuum and pressure treatment the desulfurization is increased to 20 to 25 per cent.

New Practice in Metallography.—Two important developments in metallographic analysis have been announced in recent months. One is conical or indirect illumination of the specimen under examination and the other is the effect of very high power magnification. Conical illumination, whatever its merits, is a unique development. The results are a truly beautiful picture of the structure of the steel. The chief advantage is ability to bring out depressions and elevations in the crystal formation which are entirely indistinguishable by direct illuminating methods. More details as to the formation and orientation of crystals, their slip and deformation, and more light on grain boundaries and the effects of certain heat treatment processes are among the likely results. As to high power, methods of polishing and etching have been so perfected that, with the aid of certain apparatus and photographic equipment, magnifications up to 9000 diameters have been obtained. These have revealed beautiful crystallizations which throw new light on problems in metal structure and the effect of various hot and cold-working processes.—*Iron Age,* 113:6.

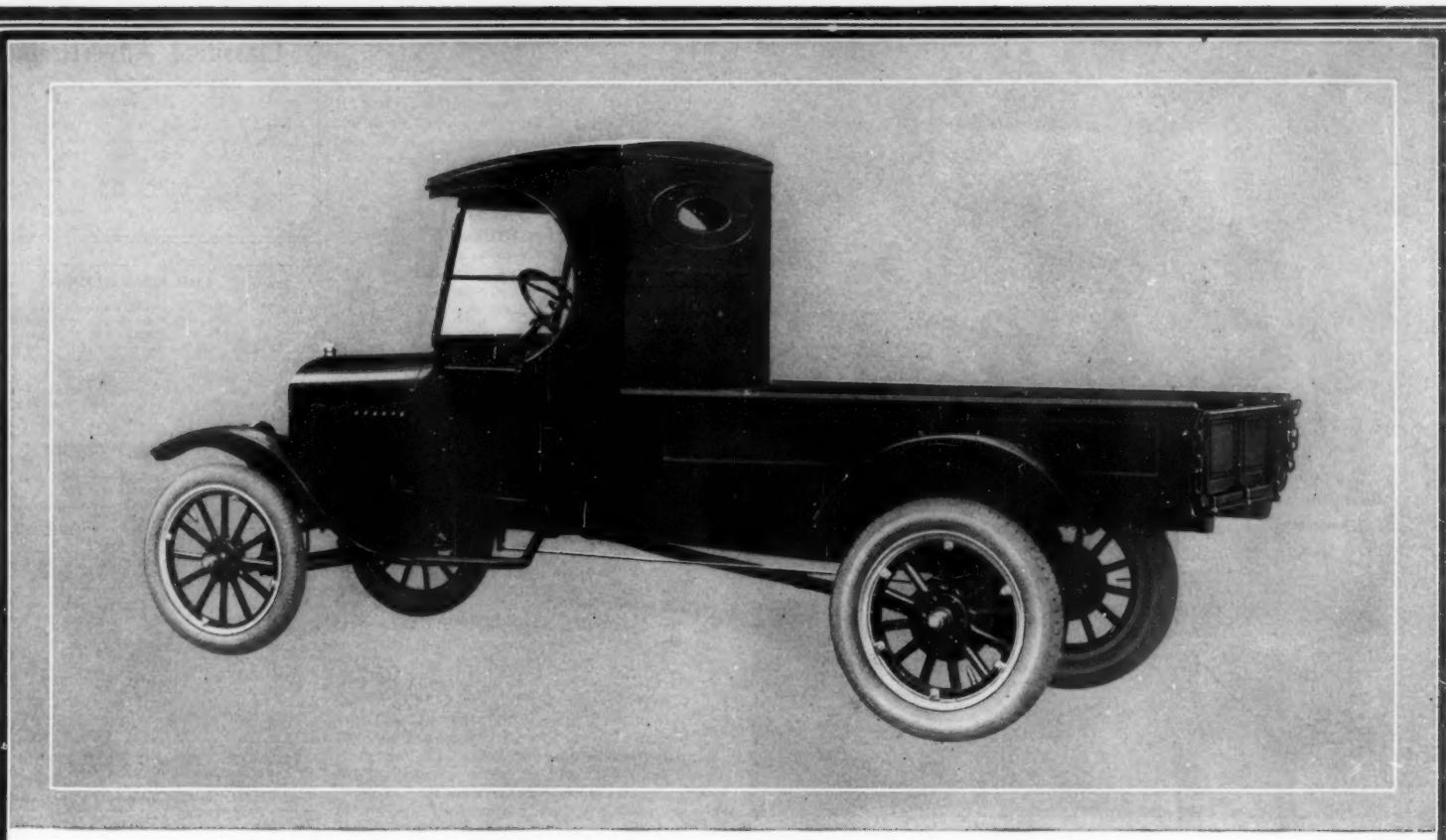
Steel Made Direct from Ore.—A French patent was issued recently to L. P. Basset of Paris on his method for making steel directly from iron ore. The process consists in subjecting the ore, mixed with the amount of carbon necessary for its reduction and with appropriate fluxes, to the action of a flame obtained by the combustion of powdered coal in the quantity of heated air necessary to insure combustion to carbon monoxide and a small amount of carbon dioxide, in such a way that in spite of the slight loss of metal due to the oxidizing action of the carbon dioxide (95 instead of 100 per cent reduction) there results an economy due to the diminution in the quantity of powdered coal involved and the easier crushing of the latter. On the other hand, the production of carbonic acid, which is accompanied by the liberation of 14,550 B.t.u. per pound, as compared with 4450 per pound for carbon monoxide, represents an important saving on fuel.—*Automotive Ind.*

Mining

The Greatest Progress in the technique of the cyanide process was made in the application of the well-known reaction by which copper and silver may be precipitated from cyanide solutions by acidification. The hydrocyanic acid thus set free may be changed back into the form of one of its alkaline salts, by the addition of an alkali, or, with a greater degree of safety, may be withdrawn by the application of a vacuum and re-dissolved in an alkaline solution. An application of the first method is described thus by Harley B. Wright: Neutral cyanide solutions deprived of free cyanide were treated with sulfuric acid. The precipitate, cuprous cyanide, was allowed to settle and was filtered, after which the solution was made alkaline again by lime and was returned to the circuit. Incidentally, 80 per cent of the gold was precipitated with the copper.—*Eng. and Min. Jour.-Press,* 117:3.

Electric Wire Safety Lamps.—Flame safety lamps have been available for over a hundred years, but during the last ten years safe and practical electric lamps have been perfected. These have eliminated many of the flame safety lamps, and in a few mines have replaced open flame lamps. But there are still more than twice as many open lamps as electric lamps in the mines of the United States, all of which the Bureau of Mines declares should be discarded in favor of an approved type of electric lamp. There are several electric miners' lamps which have been approved by the Bureau for safety and efficiency, which give good light, and which are easily maintained and carried. Some flame safety lamps will always be used, but mostly for detecting gas; although they might be supplanted if some simple, reliable, and cheap gas detector were developed. An open light and gas constitute a vicious hazard; while if there be coal dust present in the vicinity the consequences are multiplied many times. An open light and black blasting powder also constitute an explosion hazard, vividly attested by several serious disasters. Gas is released from the coal formation in numerous ways — by small feeders or blowers in the coal; by falls of roof; by drilling into or blasting vaults, horsebacks, and clay veins; from the floor—

(*Continued on page 352*)



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**Direct Factory Branches*

General Motors Trucks

GMC

Scientific American Digest

(*Continued from page 350*)

and in some places may even leak into the workings from a gas well. Nobody can say that gas will not be encountered, but it can be said that it may be sooner or later. Therefore, as a definite safety measure, the Bureau of Mines holds that the possibility of a gas release is ever present in coal mines, and that closed lights should be used. In other words, the open light is unsafe.

Tungsten Steel for Drills.—The *Mining Journal* (London) records an attempt on the Rand to use an extra hard steel of high tungsten content for drilling rock. A method has been found of welding the alloy to ordinary drill steel. The best ordinary drill steel does not drill more than 15 to 18 ins. before it is blunted and loses its gauge, and has to be resharpened. The special tungsten steel alloy costs 2s. 9d. per lb., against 6½d. to 7d. per lb. for ordinary steel; but it is claimed it will drill 48 ins. before needing re-sharpening. It is proposed to weld a short length of the high cost alloy to the ordinary steel. This has been made possible by the introduction of the electric butt-welding machine. With this machine the two surfaces to be welded are brought together in such a way as to complete an electric circuit, and in the intense heat generated at the junction of the two steels the requisite pressure is applied, and the weld is complete. With this machine nearly a weld per minute can be made, and if these welds will stand up under the repeated percussion of the hammer-drill blows in the drill-hole, there is a possibility of a big advance in technical practice. In recent years the annual consumption of rock-drill has averaged £250,000, and, even if we deduct the cost of installing electric welding furnaces, the gain of having to handle half the weight of drill steel formerly used, both on the surface and underground, and the reduction of sharpening charges, will be considerable.—*Can. Min. Jour.*

Rubber Linings for Tube Mills.—The tube mill is used for breaking up ore. Ordinarily they consist of a large tube of metal lined with alloy steel in order that the abrasion of a ton of loose moving and falling ore may cause the least possible amount of wear. Strangely enough it has been discovered that rubber forms a better lining for tube mills than steel. It lasts longer than steel. Says *Canadian Mining Jour.*, Metallurgists in South Africa have not been slow to take up the new idea. The original experiments at Cobalt, Ontario, stimulated immediate action. In Rand practice lumps of the hard, abrasive ore are used in the mills in place of the steel balls or rounded pebbles used in Canadian mills. These lumps are, of course, angular with sharp edges and are extremely tough. The first step was to place blocks of rubber between the steel liners. From this it was determined that vulcanized rubber does not wear as well as soft, raw rubber. Experiments with the latter are still proceeding and, though it is too early to conclude definitely that the soft rubber will replace steel economically, it is admitted that so far as the experiments have gone they are distinctly encouraging. First cost of the mill is very much higher when lined with rubber, but against this added cost is the longer life of the rubber, estimated as at least three times that of steel, and other advantages such as increased grinding capacity and lower power consumption. In Canadian practice a saving in power of 24 per cent has been recorded, the rubber lining being only about one-eighth the weight of one of steel.

A New Prospecting Method.—A novel development campaign by which extensive prospecting is being done with rock drills and sectional drill steel from drifts, crosscuts, raises and stopes has been inaugurated by a Utah mining company. The new method is proving highly satisfactory as to costs and time required to obtain a given amount of information. As the silver-lead ores of this mine occur in rather irregular bodies found in three favorable limestone formations, prospecting and development are of first importance. That marked economies can be made and much ore located by the new method has been proved and its use is being expanded rapidly. The progress made in developing the equipment used is interesting. In 1916, a 45-ft. horizontal hole was driven from the top of a raise to connect with and drain the East shaft of a Butte mine. The raise being rather small, 2-ft. sections of rod made from 1½-in. pipe were used, one piece being welded to a regular drill shank, the remaining sections having

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pipe threads on both ends. The necessary sleeves were provided for coupling the rods together as in ordinary pipe fitting, with the exception that the threads were cut to permit the pipe meeting end to end. Bit ends were threaded to fit the sleeves. The hole was drilled in altered Butte granite and the shaft drained. The Anaconda Copper Mining Co. developed the method still further and drilled holes to a depth of 90 ft. through altered granite and gob. During the latter part of 1923, the campaign of deep hole prospecting referred to was entered upon and carried out. As already stated, the results of this campaign have been satisfactory and the use of the method is being rapidly expanded. Normally, 12 miles of development work is done annually in the Chief Consolidated mine, and, as this consists largely of cross-cuts, much of this work can be done by drill holes at a pronounced saving. The present equipment conforms closely to that used in standard mine practice and consists of a rock drill, 3-in. single screw columns, arms and saddle, 1-in. air hose, ¾-in. water hose, drill bits, threaded drill rods, sleeves and water-connection swivel.—*Eng. and Min. Jour.-Press*, 117:9, 2 pp., ill.

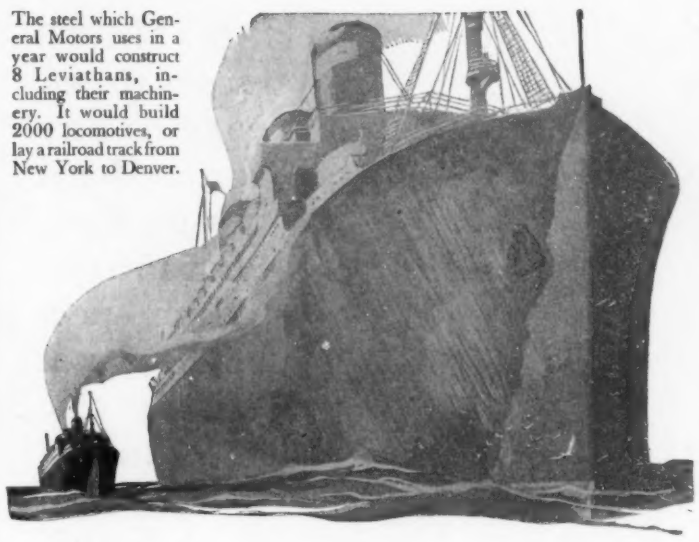
Railways

Locomotives with Flexible Wheelbase on the Garratt system are being introduced to a considerable extent in Africa and India for narrow-gage lines having heavy grades and numerous sharp curves. The largest of these engines is a 97-ton locomotive of the 2-8-0-0-8-2 class, built in England recently for the meter-gage lines of the Burma Railway and it is the first engine of its type to have eight-coupled groups of wheels. In other types of flexible locomotives the main frame extends the full length of the locomotives and is supported on one fixed and one swiveling group of wheels, as in the Mallet engine, or on two swiveling groups, as in the Fairlie engine. The Garratt engine, however, has the boiler carried on a steel deck slung between two trucks, with pivot supports on the near ends of the trucks and the cylinders placed at the outer ends. Additional adhesion weight is given by tanks and coal bunkers on the tracks. In the engine for the Burma Railway the truck bearings are spaced 32 ft. 9 in. center to center and the total length is about 70 ft. The two end driving axles and the two groups of eight 39-in. driving wheels can adjust themselves independently on curves and the engine is designed to traverse curves of 250 ft. radius. On one truck is a 1500-gal. tank and on the other is a 600-gal. tank and a 5-ton coal bunker. The weight averages 10 tons on each driving axle and 9½ tons on each of the two end axles.—*Eng. News Record.*

Americanizing German Railway Equipment.—Bulk freight traffic is an important source of revenue on any railroad, and decidedly so in Germany. One of the new objectives of the railway administration is to develop the methods of handling this class of traffic to the highest efficiency, and in line with this policy, they have gone so far as to contemplate the practical re-organization of the system of handling the commodities. They are following in this respect, certain principles which were established long ago in American railway practice. Due to a combination of conditions, the German railways are putting into service experimentally certain new types of freight car equipment which are a decided advance both as to size and weight and as to improved design, over anything which has been in use heretofore. The types are of 50 tons capacity, one for bulk freight service, and the other a flat bottom car for general service. With the introduction of the new rolling equipment, the railroads are also advancing the standards as to track and roadbed. A heavier rail, weighing 49.3 kg. per meter and designed to withstand a wheel pressure of 12.5 tons is being laid on the trunk lines. Bridges are being reinforced or rebuilt for 25 tons axle load, and eight ton-meter longitudinal load, so that a few years hence, these heavier standards will prevail on all the main lines. In handling bulk commodities, the feature of automatic unloading presents such obvious economies that its importance can scarcely be overestimated. This idea of rapid unloading is applied in the new designs of cars to the handling of commodities such as coal, coke, sand, gravel, etc. This improvement in German railroad equipment is just another indication of Germany's titanic efforts to gain world mastery in commercial life. It is the counterpart of the expansion of German industries since the war.—*Railway Rev.*, 74:6, 2 pp., ill.

FACTS ABOUT A FAMOUS FAMILY

The steel which General Motors uses in a year would construct 8 Leviathans, including their machinery. It would build 2000 locomotives, or lay a railroad track from New York to Denver.



375,000 tons of steel

MANY people suppose that all steels are alike. But General Motors metallurgists specify *45 different analyses of steel* for uses as varied as the sturdy frame of a five-ton truck and the delicate needle-valve of a carburetor.

Altogether, the companies which are members of the General Motors family use more than 375,000 tons of steel a year, equal, approximately, to 8,300 freight car loads.

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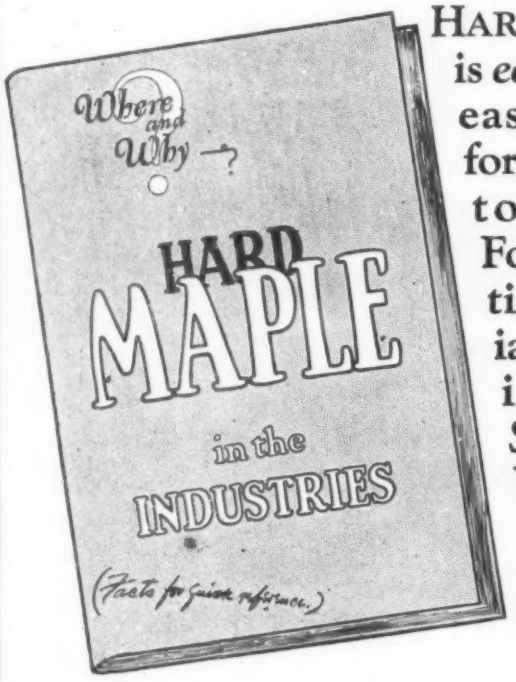

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"This is Station ———"

(*Continued from page 338*)

short-wave transmission coming in to fill the role of the ideal link between "pick-up" microphone and broadcasting station. A short-wave transmitter, located at the very scene of the radio feature, can now be employed to pick up the sounds and transmit them through space at an inaudible frequency, so far as receiving sets are concerned, to the nearest broadcasting station where the feature is received, amplified, and re-broadcasted on standard wave lengths for the radio audience; and, furthermore, if this station is a primary broadcasting station, the feature is put on the air at an inaudible or repeating frequency which will have high power to obtain distant transmission. This latter wave will be picked up by a chain of repeating stations of the same nature as the Nebraska repeating station of today.

There are a good many possible paths in the ether for these repeating waves, so we are assured by radio engineers; and with a sufficient number of properly located high-power repeating stations an indefinite number of programs will be made available for the secondary broadcasting stations of low power, which will repeat and broadcast at a frequency or wave length audible with the usual receiving sets.

The Question of Dollars and Cents

Aside from the solution of several of our present technical troubles the short-wave repeating scheme tends to solve the economic phase of broadcasting. Long has it been predicted that at some future time many of the independent broadcasters are bound to give up broadcasting, in that there are no tangible returns for their efforts and the expenses of broadcasting are steadily mounting higher and higher. Then, too, it seems but a matter of time when our radio entertainers, who now give their services so willingly for whatever publicity there may be in broadcasting their efforts, will demand remuneration for their services.

Please note how this economic phase is met by the short-wave transmission from the primary broadcasting station and the repeating stations scattered throughout the country. The primary station, located in the metropolis, is in a position to get the finest talent of the land. If the artists must be paid, then the expenses can be distributed among all the repeating stations over a wide expanse of the country. Even at the present time the American Telephone & Telegraph Company has such a plan in actual operation. Instead of short-wave transmission, this company, with its splendid network of telephone wires, makes use of telephone links to tie up the master studio with the re-broadcasting stations. In Washington the telephone company maintains a special re-broadcasting station, WCAP, which handles the same programs as the WEAF station in New York City. Then, too, the WEAF programs are sent by wire to certain stations in New England, which re-broadcast to their local audiences. Whatever expense may be connected with the securing of the programs can certainly be apportioned among the various broadcasting stations in such an arrangement, thereby tending to solve the great economic question of broadcasting.

And at the Receiving End

While the broadcasters are working on the problem of moving the programs up nearer to the listeners-in, radio engineers are at work on better and still better receiving sets. For, let us admit, many of us like radio "fishing" best of all—this business of seeing how many stations we can pick up in one evening, and how far. The author cannot help but indulge in a little reminiscencing at this point. His thoughts go back to those winter days in 1909, when he was working a crude two-slide tuning coil and a crystal detector while trying to pick up the dot-and-dash message from Fort Wood which was to tell us how we were coming through with our radio telephone transmission. The author fussed and fussed, but without success. Everything but the desired station could be heard in the head-phones; indeed, even a passing battleship had just called us up, with the short but sweet message "For Pete's sake change the tune!" The operator aboard the battleship was referring to our Anvil Chorus, which had just been played for the fifty-first time. At any rate, we finally resorted to the Postal Telegraph wires in the nearby ship-reporting tower then in use at Sandy Hook, as a quick and reliable means of hearing from our collaborators but eighteen miles away.

Fifteen years later the author sits before a neat cabinet with two simple dials on which are marked the call letters of various stations, both local and long-distance. The author glances at his watch; it is two o'clock. Then he looks through the radio program columns of the newspaper—it makes no difference what newspaper, for all newspapers *must* carry the broadcast programs of the day.

There is a program in Philadelphia at two o'clock. There is another program in Providence. Still another is on the air from Cleveland. One New York station is working at this hour. Very well. The two handles are turned until the dial pointer indicates the New York station. Instantly a violin solo comes out of the flared horn of the loud-speaker, standing alongside the long cabinet. The two handles are adjusted for the Philadelphia station, and out comes the voice of a well-intentioned lady speaking on some subject or other which has little appeal to masculine tastes. Once more the handles are adjusted until the indicators point to the Providence station. Instantly, the strains of an orchestra come drifting out of the horn with plenty of volume to fill the room, yet soft and sweet and most life-like. We linger a while, because this feature suits our particular tastes. What a boon, this business of being able to choke off undesirable programs and to select desirable ones! Finally, we set the dials again, this time for Cleveland, only to hear a fair pianist at work.

That evening we are going to visit friends—friends who have no radio—odd people, these, but perhaps they are not to blame, for their sole conception of radio is the squawking loud-speaker in front of some cut-throat radio shop. We take the radio receiver with us, together with the loud-speaker. That evening our radio receiver is placed on the living-room table in the home of our friends. We turn the knobs and bring in the President's speech from the banquet table several hundred miles away. We dance to the music of a Chicago orchestra. We tune in twenty-nine separate stations in two hours' time. And we sell the idea of radio to our friends before the evening is over.

The Rolls-Royce of Radio

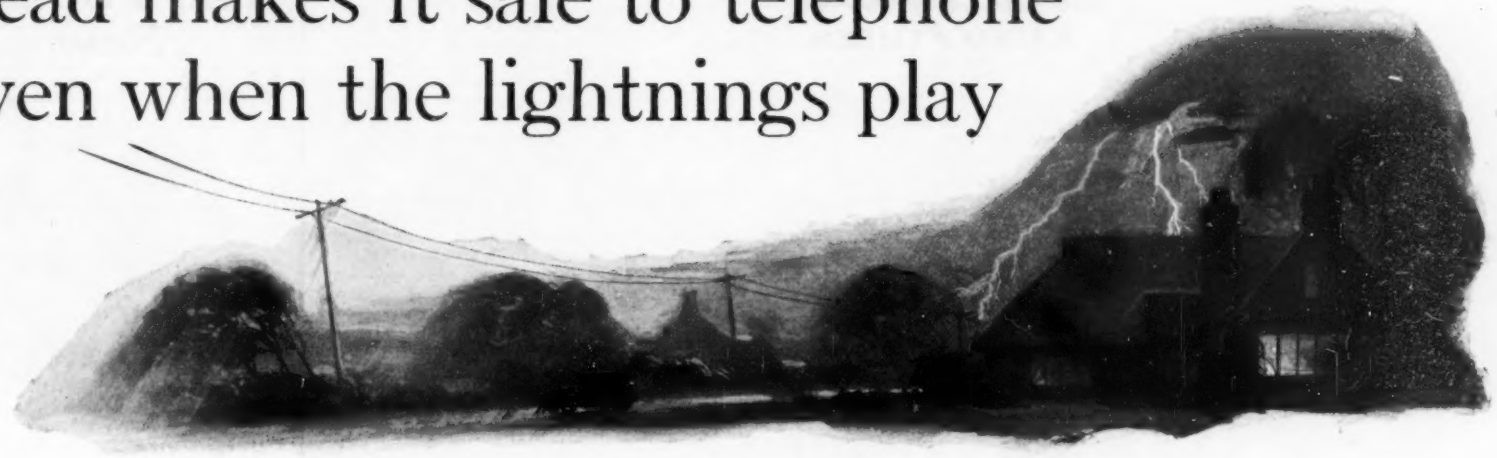
The set in question is entirely self-contained. There is no antenna connection. No ground wire is necessary. Inside the set is a small oblong frame with a dozen turns or so of wire, known as the loop, which serves to intercept the radio waves. That little loop takes the place of the elevated wire measuring 100 feet or more in length, heretofore required for radio reception. Furthermore, this set contains a few dry cells to operate the six vacuum tubes. The only external connection is that running to the loud-speaker. And even when the set is being carried about, in the automobile, street car, canoe—anywhere, the radio waves from stations several hundred miles away can be intercepted and reproduced good and loud.

Of course this particular type of set is, admittedly, the 1924 model Rolls-Royce of receiving sets. It is known as the Armstrong super-heterodyne, having been developed back in the World War days by Major Armstrong—that same young man who was working on the crude vacuum tube circuits during his college days in 1913. The super-heterodyne takes the weak energy intercepted by the small loop, plays it off against a locally generated wave, and the resultant wave is passed through radio frequency amplifiers at high wave lengths, because the so-called untuned radio-frequency amplification is most efficient at high wave lengths, and onto the detector. This arrangement makes for the utmost efficiency with simplicity.

The advent of special-filament vacuum tubes with a consumption of one-quarter ampere in some cases, and even as low as six hundredths of an ampere in others, has made it possible to multiply the number of tubes in individual receivers. Consequently, radio engineers have been able to develop new receivers in which four, five and six tubes are employed. Whereas the receiving sets first employed in radio broadcasting work intercepted the radio energy and brought it directly to the detector tube, which in turn delivered an audio-frequency energy to one or two audio-frequency amplifying tubes to be amplified for very loud headphone or even loud-speaker reception, the present day receivers intercept the same amount of radio energy but pass it through one or two stages of what is known as radio-frequency amplification, before turning it over to the detector. The consequence is

(*Continued on page 358*)

Lead makes it safe to telephone even when the lightnings play



PLAIN gray lead seems a stupid, lumpish metal. Yet when thunder crashes and lightning flashes around your house, that same lead enables you to use your telephone without danger of electrocution. Even if a bolt of lightning strikes the wires while you are talking, lead protects you from harm.

Lead is the principal part of the fuse which is used in the modern telephone system as a protection against unusually heavy electric currents. When a lightning bolt reaches the fuse, it melts the lead of the fuse. This stops the current and prevents it from reaching your instrument.

There are about 76,000,000 fuses in telephone systems in the country, and lead is in them all. More than 27,000 pounds of lead are used every year in renewing burned-out fuses.

A secondary protection

Every telephone line has, in addition to a fuse, a device called a protector. Small particles of lead in these protectors, which are both in the exchange and your end of the telephone line, melt when lightning strikes the line and break the line over which the current is traveling toward you. The amount of lead used in this way is about 1,000,000 pounds. Renewals require the use of about 700,000 pounds more every year.

How lead helps you phone

Lead in fuses is only one of many uses to which this metal is put in the telephone system. Every time you telephone you summon the help of lead. In the telephone instrument and box is an average of 51 soldered connections. Lead is in all of them. Exchanges in the United States and telephone lines running out of them have billions of soldered connections, with about 322,000,000 pounds of lead in them. Changes in connections require the use of about 70,000,000 more pounds of lead every year.

Sheaths of lead

Millions of pounds of lead are necessary to provide snug coverings for telephone cables. One company uses in a year more than 53,000,000 pounds, to cover 35,300,000 feet of cable. Today there are in this country about 82,000 miles of telephone, telegraph, radio and elec-

tric light cable covered with lead — 327,300,000 pounds of it. Along this cable are more than 6,000,000 pounds of lead for connecting and sealing the ends of cable to keep out moisture, and for terminal boxes.

Where you see lead most

IN telephone systems, you do not see it or realize the important work lead is doing. But in paint, lead in the form of white-lead, the basic lead carbonate, and red-lead, a lead oxide, is known the world over. And after all, it is this use of lead that is most universal.

For generations painters have used white-lead on such surfaces as wood, and red-lead on metal as standard protection against the assaults of the weather. Rot cannot destroy the house whose surfaces are covered with pure white-lead and pure linseed oil. Rust cannot attack the iron and steel that are thoroughly protected with red-lead.

Property owners who jealously protect their money investments know from experience that white-lead gives the surest protection for the surfaces of their houses. These owners have learned the truth of the words, "Save the surface and you save all." They realize now that the cost of good paint is secondary to protection of the covered surface.

Producers of lead products

Dutch Boy white-lead is the name of the pure white-lead made and sold by National Lead Company. On every keg of *Dutch Boy white-lead* is reproduced the picture of the Dutch Boy Painter shown below. This trade-mark guarantees a product of the highest quality.

Dutch Boy products also include red-lead, linseed oil, flatting oil, babbitt metals, and solder.

National Lead Company also makes lead products for practically every purpose to which lead can be put in art, industry and daily life. If you want information regarding any particular use of lead, write to us.

If you wish to read further about this wonder metal, we can tell you of a number of interesting books on the subject. The latest and probably the most complete story of lead and its many uses is "Lead, the Precious Metal," published by the Century Company, New York. If you are unable to get it at your bookstore, write us or the publishers.

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New York, 111 Broadway; Boston, 131 State St.; Buffalo, 116 Oak St.; Chicago, 900 West 18th St.; Cincinnati, 659 Freeman Ave.; Cleveland, 820 West Superior Ave.; St. Louis, 722 Chestnut St.; San Francisco, 485 California St.; Pittsburgh, National Lead & Oil Co. of Pa., 316 Fourth Ave.; Philadelphia, John T. Lewis & Bros. Co., 437 Chestnut St.

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PATENT NOTICE
Cunningham tubes are covered by patents dated 2-13-08, and others issued and pending. Licensed for amateur, experimental and entertainment use in radio communication.
Any other use will be an infringement.

The care and operation of each model of Receiving Tube is fully explained in our new 40-page "Radio Tube Data Book." Copies may be obtained by sending ten cents to our San Francisco office.

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Radio Notes

The Invisible Loud-Speaker.—Along with the tendency to place all radio equipment in a fine cabinet so as to find a place for it in the living-room, there is a tendency to place the loud-speaker in a cabinet. Several of the present offerings are in the form of attractive cabinets, provided with a scroll and screen front. Just as in the case of the modern phonograph, it seems almost certain that the awkward loud-speaker horn must eventually disappear into a cabinet.

Radio Frequency in a Handy Package.—There has lately appeared on the market a vario-transformer which simplifies the problem of radio-frequency amplification. Instead of having a transformer with fixed windings, this vario-transformer has an adjustment which tunes it accurately for all wave-lengths between 200 and 600 meters. Perfect shielding and pig-tail connections assure clear tones. Furthermore, the amplification is uniformly maintained throughout the broadcasting range. This vario-transformer is put out as a separate instrument, and also in conjunction with a socket and rheostat, all mounted on a neat base.

Keep Matches Away from the Charging Battery!—It is not generally known, unfortunately, that a storage battery on charge is giving off hydrogen gas, and that this gas, when mixed with the oxygen of the air, forms an explosive. For this reason one should keep one's face and lighted matches away from the vent of a battery while it is on charge. The small vent of the battery is sufficient to permit the escape of the hydrogen gas, under normal conditions. In the presence of a flame, however, the hydrogen gas, mixed with oxygen, may ignite and the battery may very well be blown to pieces. One should use an electric flashlight in looking into the charging battery to see the level of the electrolyte in each cell.

What Resistance for the Rheostat?—One of the several questions which arise in the construction of a home-made receiver is the resistance of the rheostat. There are three general classes of rheostats, so far as resistance rating is concerned. Hence it becomes necessary to classify the tubes in three groups, in selecting the proper rheostat. A rheostat of 6 ohms is necessary for tubes of 5-volt rating. A 20-ohm rheostat is used for the tubes of 3-volt rating. A 30-ohm rheostat is used for the 1½-volt tubes. As for the carbon rheostats, they may be used with any type of tube since they have a range of resistance from zero to 30 ohms or more, thus covering the complete range of resistances.

Regeneration and Radio Frequency.—While it is true that the regenerative circuit is making way for the radio-frequency circuits, the fact remains that the old regenerative circuit, when properly designed and constructed, gives an amplification equal to between two and three separate stages of radio-frequency amplification. Beyond doubt, it is the most economical type of circuit, but, unfortunately, in the hands of the inexperienced operator it is allowed to oscillate and therefore becomes a miniature transmitter to annoy the radio audience in the immediate neighborhood. When it comes to loud-speaker operation, the single-circuit regenerative receiver, together with two stages of audio-frequency amplification, gives the best results at the lowest expense. It is unfortunate that regenerative sets are in the hands of so many unskilled laymen who have made this otherwise efficient type of receiver a perfect pest to broadcast listeners.

The American Telephone & Telegraph Company's Suit against the operators of the local WHN station in New York for the infringement of radio patents, is a matter of considerable concern in radio circles. It appears from what has been officially stated by the telephone officials, that the whole purpose of the present suit is to protect the patents of the telephone company, which are being infringed with impunity by many broadcasters. On the other hand, numerous broadcasters have come forward with the charge that the telephone company is seeking a monopoly of the air, to the end that it may place broadcasting on a strictly commercial basis for its own gain. This charge is vigorously denied by the telephone company. At the present writing it is unwise to comment one way or the other. There is no doubt, of course, that the telephone company's patents are being infringed by hundred of broadcasters. There is no doubt, too, that there are too many broadcasters, especially of the mediocre kind. But whether it is wise for the

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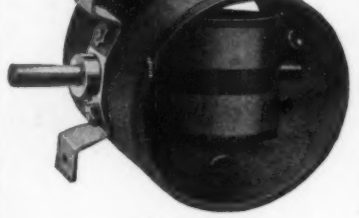

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telephone company to make the path of the broadcasters still more thorny by charging for the use of patents, remains to be seen, although there can be no question of the legality of such a move.

Tesla and His "Wireless Power."—It is many years since we have heard from Nikola Tesla, the well-known electrical inventor and the father of numerous rather startling and fantastic ideas. At the age of 67, Tesla now states that he is on the very threshold of an age which will see the transmission of power over vast distances by means of radio. "Since my original experimental demonstration," states Tesla, "I have made great improvements and can now definitely announce that the loss in the transmission to the greatest terrestrial distance, say 12,000 miles, will not amount to more than one-quarter of 1 per cent. This, of course, does not take into account certain unavoidable losses in transmitter and receiver, which will amount to about 4 per cent in the aggregate. In conveying energy through wires the loss amounts often to 20 per cent or more, and the distances are limited. Such a plant could be put into operation immediately, for I have developed all the details. I shall commence construction in the very near future, relying upon my own resources."

The Transinductor.—In the February issue of this journal, under "Inventions New and Interesting," there was described the transinductor. This new transforming apparatus was designed and invented by Clinton H. Hulbert, instead of E. W. Kersten as stated in the article. One of the latest types of transinductors is applied as a push-and-pull radio-frequency transformer. This is the first instance of push-and-pull radio-frequency amplification. Push-and-pull amplification applied to radio-frequency with the use of transinductors is said to overcome distortion, increase amplification, and give super-selective tuning; in fact, it has similar advantages to those of the well-known audio push-and-pull amplification in audio-frequency. The push-and-pull transinductor by means of one dial is capable of controlling the magnetic inductance, capacity, and iron. It acts as a complete wave-length tuner, at maximum efficiency, from 200 to 600 meters. It requires no variable condenser or any other control to bring ouf super-selectivity and sensitiveness in receiving, according to the inventor's claims.

Short-Wave Transmission is now attracting no little attention. According to *Wireless Age*, broadcasting stations, by means of short-wave transmitters, are now able to send their programs over great distances by day as well as by night. This is indicated by the results of short-wave broadcasting experiments which have lately reached almost unbelievable results. The feat whereby American broadcasting programs are repeated on these short waves and received and rebroadcasted by English stations, thus reaching the peoples of Great Britain, France, Germany, Belgium and the Scandinavian countries, is the outcome of two years' experimenting and perfecting of high-frequency apparatus by Frank Conrad, assistant chief engineer of the Westinghouse organization. Last October the Westinghouse company inaugurated the first radio repeating station, known as KFKX, at Hastings, Nebr. This repeating station ever since has been receiving the high-frequency wave sent out by the parent station KDKA at East Pittsburg, Pa., simultaneously with the transmission of the usual KDKA broadcast wave. One of the most striking things about the short-wave transmitting set is the extremely short antenna used. The antenna at KDKA for use with the short-wave transmitter is slightly in excess of 35 feet, in striking contrast with the 200-foot antenna used for regular broadcasts. The great difference in frequency between the short-wave broadcasts (under 100 meters) and the common wave length band, approximately 360 meters, can be noted by comparing the kilocycle frequency of two such waves. KDKA commonly transmits to England on a wave length of 94 meters, which is a frequency of 3,200 kilocycles. At the same time KDKA is broadcasting to its regular broadcast audience on a wave length of 326 meters, which is a frequency of 960 kilocycles. Tests have proved that the high frequency broadcasts go farther with the same power input than the ordinary broadcast waves. It has also been proved that daylight has little effect, if any, on this carrying power. These two qualities of the short waves are going to produce a marked effect in the future of broadcasting.

"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

Get ready *now* for summer radio

YOUR radio batteries have served you well and faithfully over the long winter months. Now a great radio summer is at hand. To enjoy summer radio at its best, equip your receiver with the best batteries you can get. Put in new Eveready Radio "B" Batteries and see what wonderful, long-lived service they will give.

Made especially for radio use, Eveready "B" Batteries will operate the loud speaker at maximum volume for long or short periods, depending on how rapidly the current is taken out of them. Packed full of pep and punch and go, Eveready "B" Batteries pour out their power the moment you turn on the tubes. Scientifically made for long-lived radio service, the cells renew their vitality when idle—responding instantly with fresh vigor.

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THE FLORSHEIM SHOE COMPANY
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The Florsheim SHOE

"This is Station ——"

(*Continued from page 354*)

that the weakest radio energy is built up many fold before being turned over to the detector for conversion into audio-frequency current. The detector is very much like the trigger of a gun, in that a certain amount of force must be applied before it will operate or "shoot." Thus the weak radio waves may not be strong enough to "trigger" the detector tube, and no amount of audio-frequency amplification after the detector will be of any avail if the detector has failed to operate or "shoot."

There are all kinds of radio frequency amplifier sets in operation. The neutrodyne is perhaps the most popular, for aside from its remarkable efficiency it has the marked advantage of being absolutely stable in adjustment. With its three tuning controls once charted for the various stations, the operator of the set can always tune in any desired station by setting the three dials to the numbers indicated on the chart.

There are two broad classes of radio frequency amplifiers, namely, the tuned radio frequency, in which the successive steps or "stages" are tuned, and the untuned type in which the coupling of one step or "stage" to the next is accomplished by special transformers of fixed wave-length.

The old principle of regeneration, which makes the detector tube serve as a detector and a radio-frequency amplifier at the same time, is still found in the latest types of receivers. However, certain precautions are taken so as to prevent the regenerative action of the detector tube from emitting a wave when the regenerative action is forced. The combination of so-called tuned radio frequency and regeneration is quite popular today.

There are receivers in which the vacuum tubes are made to work at two jobs at one time, just as in the regenerative set. Thus in these sets, which are known as reflex sets, the same group of tubes are employed first as radio-frequency amplifiers and then as audio-frequency amplifiers. Thus it becomes possible to make a given number of tubes do the work of twice that many when using the conventional methods.

Of radio circuits, there is no end. Basically, however, there are about a half-dozen circuits. The layman is bound to be confused when confronted with dozens upon dozens of different circuits, accompanied by the most fantastic claims. Little wonder, therefore, that many laymen prefer to hold back from buying their radio set, because they have a distinct "hunch" that the ideal set has not as yet been evolved from the bedlam of receiving circuits. Yet the fact remains that our fundamental circuits of today are highly efficient, and we are not likely to replace them in a hurry.

Putting the Atom to Work

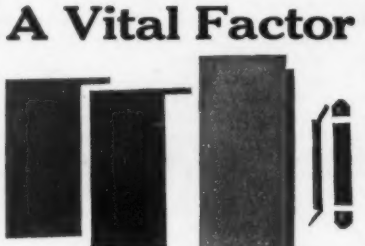
(*Continued from page 306*)

electrical, or in other words an etherial property; that inertia or massiveness is not due to something *in* the ultimate unit of matter, but to something surrounding it. The observed inertia of an electric charge may be ascribed to the ether which it carries with it. But that is too vague and indefinite to be useful. It is preferable to say that inertia is explicable in terms of electromagnetism: that every electric charge has a certain mass associated with it, and that in an aggregate of electric charges their masses are added together.

But here comes the delicate point. When electric charges are squeezed close together they interfere with each other to some extent. The positive and the negative tend to neutralize each other. If they could be jammed into complete coincidence it must be supposed that they would obliterate each other. That, as far as we know, is not possible. But they can approach very near each other. And in that case their effect is neutralized as regards distant observation, or at least almost neutralized; and their inertia is diminished. Two opposite charges at a reasonable distance apart will have double the inertia of one. But if you pack them too tightly together, the combined inertia will be less than double. Some of their mass will apparently have disappeared, gone out of existence.

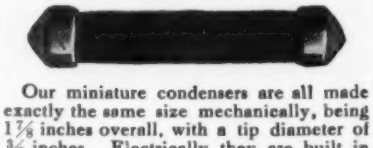
Now we said that a helium nucleus, if it consisted of four atoms of hydrogen, must have those four atoms packed very tightly together. There are four positive charges held together with two negative charges; and the tight packing would result in a diminished mass, a loss of weight; the aggregate will not weigh four times the original unit, but something less. In other words, not four

A Vital Factor



If reliability is important in the larger and more conspicuous apparatus, it is even more so in the small and often concealed parts, where a flaw will nevertheless prevent absolutely the working of the set.

That is why Kellogg miniature condensers are designed and manufactured with the same painstaking care as the famous variable condensers and other larger parts.



Our miniature condensers are all made exactly the same size mechanically, being 1⅞ inches overall, with a tip diameter of ⅝ inches. Electrically they are built in seven different capacities from 250 micro-microfarads (No. 506) up to .01 microfarad (501).

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times 1.0077, but only four times 1. That, is the kind of thing to be expected. That would account for the disappearance of the .0077 which belongs to hydrogen isolated, but not to the hydrogen used as the building brick for other atoms. Helium and all the other atoms may be composed of hydrogen, but of tightly packed hydrogen. And, accordingly, hydrogen in combination is 1, while hydrogen free is 1.0077.

But this looks as if matter could go out of existence. How is it possible for the seven or eight parts in 10,000 parts of hydrogen to disappear? What about the doctrine of the indestructibility of matter?

But we have never yet said that it left no trace behind. That is just what we have to consider. If matter ever disappears, what are we to expect instead?

Here comes in the theory of relativity, which states that in some sort matter and energy are interchangeable. If energy disappeared, we must expect to find generation of matter; and if matter disappeared, we must expect to find evolution of energy. Now, so far as we have gone at present, neither of these things has been done in the laboratory. No one has seen matter converted into energy, or vice versa. It would be an important day when it was done. But I expect that some day it will be done.

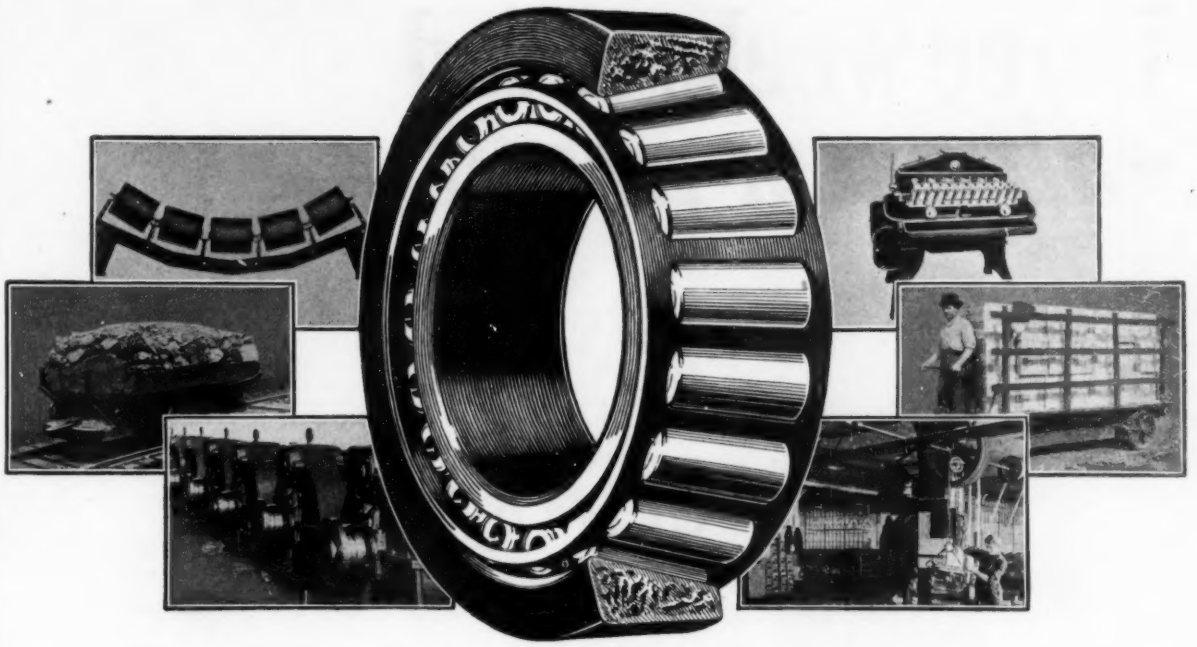
We might stop to ask for a minute how this can possibly be understood. What physical notion can we form of the conversion, or inter-relation, between matter and energy? In my view, only through the intervention of the ether. The ether has associated with it an absolute well-known, though great, velocity—the velocity with which it can transmit waves; but which is also, in my belief, a constitutional velocity, technically called the velocity of light. Parts of the ether which are circulating in vortex or rotational motion with this velocity, are what we must look to for the explanation of the fundamental part of atoms of matter. A whirling structure in a fluid would simulate solid properties and would have an identity of its own; as Helmholtz and Lord Kelvin long ago showed. If then this individual circulation is interfered with or opened out, its energy becomes conspicuous. It ceases to be a matter unit and becomes an energy unit.

But the energy of anything moving or circulating with the velocity of light is something portentous. For the energy involves the square of that velocity. And even a grain of dust moving at that speed could do work equal to thousands of foot tons. The energy of one-tenth of a milligram, the smallest visible or weighable speck, moving with the speed of light, equals that of a load 600 tons falling a mile.

If then the whole of any perceptible portion of matter disappeared, the energy resulting would be prodigious. When hydrogen is packed into helium, the *whole* runs not the slightest risk of disappearing. But seven or eight parts in every 10,000 do disappear. The 1.0077 becomes one. And though the disappearing fraction is small, yet the total of which it is a fraction is so gigantic that the result would put all our other sources of energy to shame.

But we have not learned how to pack hydrogen into helium or into any other of the heavier atoms—as yet. No, not yet. And yet it would appear that it must have been done, some time and somewhere; perhaps in the interior of stars, certainly in ways at present unknown. And, if so, some of the energy associated with matter may be accounted for. This is believed to be why the stars are hot. I suggest that some small fraction of this outburst of energy may account for their rapid motion. All the heavenly bodies are moving, and all the big ones are hot, roughly speaking. The total energy is beyond anything that can be accounted for by any of the forces known to us, by any except what is here suggested.

Ordinary combustion is due to the packing together of atoms into molecules, a very loose kind of coupling, giving a very small amount of energy. The packing of atoms into atoms is a much closer and more violent kind of phenomenon. And the undoing of atoms into non-circulating ether is the most violent of all. The sun is hot enough; but some of the stars are several thousand times hotter. So that the amount of energy confronting us in space is majestic. But there is no difficulty at all in accounting for it on the lines here indicated. And if ever the human race get hold of a means of tapping even a small fraction of the energy contained in the atoms of their own planet, the consequences will be beneficent or destructive according to the state of civilization at that time attained.



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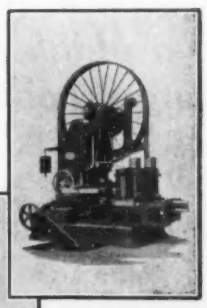

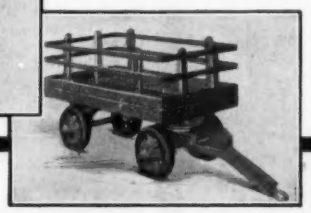

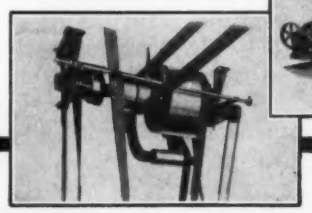

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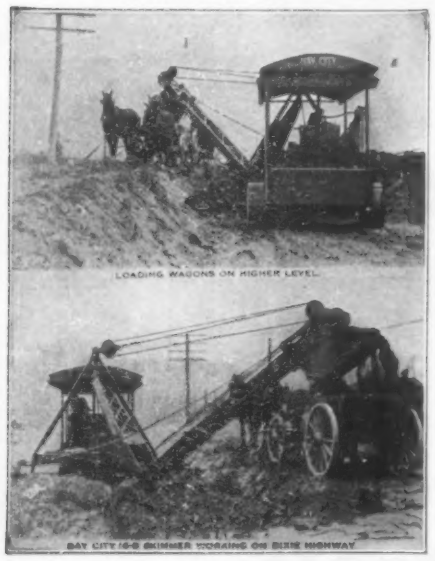

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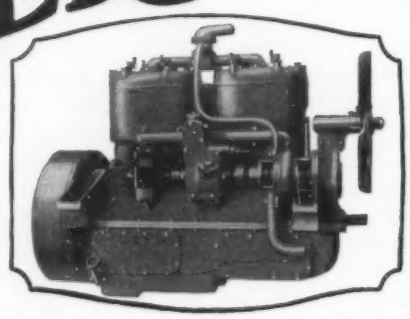

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When, Where, Why?

(*Continued from page 312*)

traffic. This is a constructive suggestion for preventing accidents, and one which could not possibly be made in the absence of *complete* figures for *all* the accidents of a whole state; for in the absence of such figures, your guess that most accidents occur to new cars is as good as Commissioner Stoeckel's guess that most occur to old ones.

Much discussion goes on, in and out of the daily press, as to just how much reckless driving and reckless walking there is, and just how responsibility for the sum total of automobile accidents should be divided. If you ask this question in New York, again your guess or my guess or anybody's else guess is just as good as that of the Police Commissioner or the head of the city's court system. But if you ask it in Connecticut, there is no guess-work at all in the answer. It will take the Commissioner's office staff about three minutes to find out for you just what percentage of the state's motor accidents are due to recklessness of the operator; what percentage to carelessness of a pedestrian; what percentages to the carelessness of a "contributor" (see below), to bad equipment, to carelessness of an occupant of the car, to miscellaneous causes involving no apparent carelessness at all.

Under operating recklessness the Connecticut system of tabulation lists twenty-one items, and it will be interesting to go down this list. Intoxication; speed too great for the conditions; cutting in; passing a standing trolley; passing on curve, on hill, on wrong side; trying to beat a train to the crossing; cutting corners; parking on the wrong side; failure to grant right of way; inattention; following the car ahead too closely; runaway car through failure to set brakes, through cranking while in gear; confusion; skidding; careless backing; inexperience; driving on the wrong side of the road. Pretty complete catalog of the motoring sins, is it not? Could you draw up so exhaustive a list of "don'ts" without a file of accident reports to refer to?

The pedestrian displays carelessness in seven ways, according to the official classification. He gets intoxicated; he gets confused; he plays in the street; he steps from behind another vehicle; he boards or leaves a trolley improperly; he coasts; and he crosses the street at a time or place where he shouldn't or without due attention to his course.

"Contributors" whose carelessness aids in bringing on accidents are the motorman, the cyclist, the teamster, the gateman or flagman, the push-cart man, the runaway horse, the animal of miscellaneous sorts, and the unknown operator of another car who succeeded in getting clean away.

Defective equipment of course usually means bad brakes, glaring headlights, or inadequate headlights. It may also be the steering gear; and tires today are sufficiently reliable to make it reasonable to presume that one that blew out was defective within the possible knowledge of the owner. Obscured vision is defective equipment when not due to the rain or snow or fog that is actually in operation at the moment; if it is clear, you are responsible for being able to see through your own windshield. Then there is a miscellaneous category here.

The occupant of the car may display carelessness in jumping on or off a moving vehicle, in the fact that his very presence there constitutes stealing a ride, or in interfering with the operation of the car.

Under miscellaneous causes chargeable to nobody in particular are road obstructions, weather conditions, unprotected railroad crossings, and ignition of the gasoline.

Now it is self-evident that the very analysis of accidents among this series of causes is a mighty educational undertaking. When we can, in addition, state exactly what percentages of the accidents occurring in a given area within a given time are to be attributed to each cause, we have made a very long step indeed toward prevention. We know in what direction to turn legislation, propaganda, popular education. We know what it is that we are trying to prevent, instead of merely guessing. In the present article, no attempt is made to show what percentages of accidents are due to the various causes; we leave that for future treatment. What we are pounding on here is the practical necessity for just such a census of accidents as Connecticut's, based upon just these data—reports of every accident, from those involved.

If the figures are available as a means of keeping the bad cars off the road, they are equally available as a means of keeping off the bad drivers. The Commissioner has a file in which are kept, for identification purposes, little index cards showing names, addresses and license numbers of all Connecticut's licensed operators. When the year runs out, these are not destroyed; they are transferred to a permanent file, in which they are arranged alphabetically, and in which appears a complete record of every person who has been licensed to drive in Connecticut since this file was started. Ultimately, of course, it will have to be weeded out up to a certain arbitrary date; but this will not rob it of its value.

The essential details of every accident are entered upon cards of corresponding size to the license cards in this file, but of different styles and colors; and one of these cards is put in the file of each operator involved. Trials, suspensions, revocations—everything that constitutes part of one's record on the road—all this goes in. In dealing with every accident of today and tomorrow, the Commissioner has available this complete record; he can make it available to the court, or he can avail himself of it by demanding that cause be shown why the license should not be revoked. In some jurisdictions you can go right on having the same sort of accidents indefinitely, and none of the old ones will bob up in court to prejudice your showing in the latest one. But not so in Connecticut; if you are temperamentally unfitted to drive a car on the public roads, the Commissioner will find you out.

So much for the cause of the accident, the car, the driver. There is one other important element, the place. Whatever the cause which the judicial sifting-out process hits upon as the proximate one, it is usually the case that the physical conditions surrounding the scene of the wreck made some contribution. The most reckless driver does not have a smash-up every minute, or even a narrow escape; his close shaves and his smashes occur at points where there is some physical hazard, however minute, lying in wait for him.

Commissioner Stoeckel has formulated a program of identifying these physical hazards, and so far as possible eliminating them. Large-scale maps of the leading cities —New Haven, Bridgeport, Hartford, etc.— are posted on his walls, and every time an accident occurs in one of these cities the spot at which it happened is tabbed on the map. Ultimately the system may be extended to cover the whole state; already it has been extended to numerous cities which it did not originally cover.

For the year's first accident at a given point (usually a corner, of course), a triangular-headed pin is inserted, carrying the numeral "1." If no further smash comes at that spot during the year, the original pin is not disturbed. If a second follows the first, the "1" pin is replaced by one of the same shape that says "2." When the roll for a given point reaches six, the shape of the pin changes, and the numerals from "6" upward are carried on square heads. It is then easy enough to pick out the places where accidents are habitual from those where they are not habitual. Along toward the end of the year, the Commissioner's accident map for one of his cities looks like the picture on page 312.

As soon as the accident map makes it clear that accidents are in the habit of coming at a given corner, an inspector is sent out to look that corner over and find its physical defect. If the bulk of the smashes have occurred at night, the illumination is naturally suspect, and he looks for glares or shadows. Other suspicious parallelisms between the several accidents at a given spot furnish other leads. Sometimes it is one thing, sometimes another; always the inspector will find out what it is, and usually, unless it be pure unadulterated congestion, a remedy can be found. One of Hartford's plague spots was a five-corners, and the danger was taken out of it by routing all traffic through it circularly. Again the prohibition of left-hand turns spells remedy. Sometimes it may be found that a rough spot in the pavement distracts the driver's attention at the critical moment and renders him peculiarly liable to getting hit; again the combination of grade and intersection may be one calculated to make the uninformed driver lose control temporarily, or there may be a blind spot which can be eliminated.

In one case, the police authorities of a city of some 40,000 were in total ignorance of the existence of the worst trap in the city; when they were informed by the Com-

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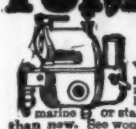

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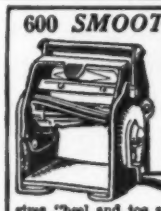

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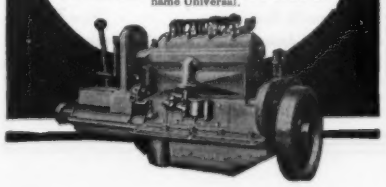

missioner's office that an excessive number of accidents were occurring at this point they laughed, and insisted that there must be a mistake. There was none, however, either in the diagnosis or in the remedy that was applied.

There can be no complete elimination of accidents—that should be obvious. But just so sure as it is found that accidents keep coming at the same point at the rate of four or five or more a year, just so surely can a remedy be found. There appears no way of learning about the reiterated mishaps, however, short of the reporting of all accidents to the proper authorities, and the careful recording of the data thus received, in substantially the fashion followed in Connecticut. From this angle alone, any other branch of the state administration could handle the matter as well as the registration bureau. But from all angles combined, it is very clear indeed that in no other way can so much juice be squeezed out of the accident statistics as when these are in charge of the office that registers cars and operators. The three functions of registration, traffic-law enforcement, and collection of data belong naturally together, and they are divorced only at the expense of efficiency. They are neglected or omitted only at a still heavier cost. If one of the major avenues of attack upon the traffic problem lies through uniform laws, another, and equally important one, is to be found in the gathering of accident data under a law modeled after that of Connecticut, and in an administrator who will model his work after that being done in Connecticut. If this system were faithfully in force everywhere, the SCIENTIFIC AMERICAN believes that accidents would be reduced at least 25 per cent.

Our Abrams Investigation—VIII

(*Continued from page 313*)

regards it as an improvement on the patho-clast. While both the patho-clast and the ..... machines are emanations from the Abrams machine, nevertheless both have points of difference from it as well as from each other. Dr. ..... is trying very hard to get out a mechanical diagnostic machine and thinks he is on the way. He tells me that he can now throw a vibration into a man which will cancel out his sight and when he takes his hand off the machine his sight immediately returns without any damage."

This letter was accompanied by the report of the diagnostician, written on the letterhead of his electronic laboratory. From the letterhead we gather that this laboratory, aside from its diagnostic and treatment work by means of electronic reactions, also manufactures electronic equipment. We quote from the report:

"The two specimens of handwriting received by you from the Scientific American and forwarded to me have been examined. The following is a report of the findings:

"1. Our case A—Upper 6th right.

"2. Our case B—Lower 6th right and lower 6th left.

"As you know, I have never been very keen about doing any diagnosing from handwriting as the amount of energy which can be absorbed by the ink is very small in comparison with my method in charging a phial. However, even though I have been successful in every localization that I have attempted in this manner, one is apt to make a mistake and I trust that the Scientific American will take this into consideration.

"From my past experience and experimentation I find that my method is only 80 per cent accurate, which percentage I am sure I could prove in a series of tests. I might add that my methods do not embody all of the fantastic claims that have been credited to the work."

Let us analyze the results of this test: The diagnostician states that he finds an abscessed condition in our case A's upper 6th right tooth. According to the dentist, that particular tooth is sound and free from abscess. The tooth immediately ahead, however, was abscessed and therefore removed. At the time the handwriting specimen was taken there was no indication whatsoever that the upper 6th right tooth was infected. And if the electronic diagnosis is to be considered as accurate, it should have referred specifically to the second upper right bicuspid, which was the badly infected tooth as already stated.

The diagnostician states that our case B's electronic diagnosis indicates infection in the lower 6th right and lower 6th left. The dentist's report of this case, as already stated, indicates a bad infection of the upper right central and upper left lateral. Surely, if the electronic diagnosis were to

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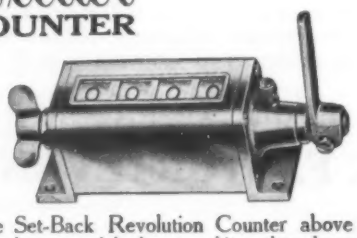

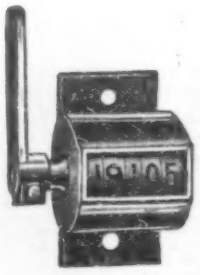

The Set-Back Revolution Counter above records the output of the larger machines where the revolutions of a shaft record operations, or output. Counts one for each revolution, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price, with four figures, as illustrated, $10.00 (subject to discount).

The Small Revolution Counter at left records the output of smaller machines where a shaft revolution indicates an operation. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially adapted to light, fast-running machines. Will subtract if run backward. Price, $2.00.

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be considered reasonably accurate, it should have found those predominant and highly developed sources of infection. The dentist's records show that, contrary to the electronist's findings, the lower 6th year molars were missing.

It must be apparent that the electronist has failed to score even a modest success in this diagnostic test. This is rather disappointing, in view of the previous correspondence we had with the Los Angeles gentleman, reading, in part: "Now as I have said before I know the method will diagnose an abscessed tooth so why not put me to the test. Send me on a specimen of the handwriting on plain white paper and in plain envelope of one or two people whom some dentist will vouch for their having abscessed teeth. Use separate envelopes to avoid mixing the 'vibrations' and let each patient write his own name or anything he pleases, send on to me and I will send you back name of the tooth of each patient. Dr. ..... here has always done this stunt correctly and I see no reason why he should fall down with you." Not until actually called upon to make a test is there any suggestion of possible failure; then this suggestion is put forward quite strongly!

Aside from the obvious failure of the electronist in this particular test, there is another highly significant fact which bears considerable thought. It will be noted that the electronist found the upper 6th right in one case, and the lower 6th right and the lower 6th left in the other. In effect, these teeth are all of the same kind. Perhaps this is merely a coincidence, but at any rate it is a possibility for which we were quite prepared in advance.

A brief review of the records in our co-operating dentist's office disclosed the fact that a very large percentage of dental work is done on the sixth year molars. The dentist's explanation as to the cause for such preponderance of trouble in those specific teeth, is that the 6th year molars are the first large teeth in the mouth, usually making their appearance at the age of from five to six years. Furthermore, our co-operating dentist informs us that in any diagnosis of teeth infections or ailments without a complete examination, he would say offhand that the trouble existed in the 6th year molars.

Our Abrams Investigation Committee fails to be impressed by this test of localization. In view of the electronist's claim of 80 per cent accuracy in his diagnostic work, we are frankly disappointed. As for the small amount of energy derived from handwriting as compared with a blood specimen, we can only state that we sent precisely what was asked for. Furthermore, certain electronic workers have time and again stated that handwriting was as effective as blood specimens.

This test must stand as our only evidence of the efficacy of the electronic localization work until other tests are entered into between electronic workers and ourselves. Again we solicit electronic workers to co-operate with us in tests to the end that we can arrive at the real truth of the entire electronic controversy.

The History of Engineering

THERE comes to hand a most interesting volume, the Transactions of the Newcomen Society for the study of the history of engineering and technology. This body, whose scope is well indicated by the full name quoted, has its headquarters in London and the bulk of its membership is British. The President of the Society assures us, however, that they are anxious to have the Society regarded as an international body, and that American members would be welcomed most cordially. We know of no such body in this country, and one whose interests lie in the field of technologic antiquities would find his fees well repaid by the Transactions alone. Some idea of the scope of these may be got from a statement of the more important papers included in the volume before us. We note discussions of the early history of mechanical handling devices, of Greek and Roman engineering instruments, of mechanics and engineering from Aristotle to Archimedes, of Timothy Hackworth and the locomotive, of Heaton's steam carriage, of Gurney's railway locomotives (both of these from 1830), of Brunton's steam horse of 1813, and of several other interesting items. In addition there is included in the volume a very useful bibliography of historical subjects, and it is the intent to continue this in succeeding volumes until it is brought down to date. The Secretary of the Society is Mr. H. W. Dickinson, M. I. Mech. E., the Science Museum, South Kensington, London S. W. 7.

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A New Disinfectant.—According to the *Pharmaceutical Journal* a new disinfectant of excellent properties has appeared on the market under the name of acrosyl. It is both a saponified antiseptic disinfectant and a deodorant. It is a cresol preparation containing 50 per cent tar acids, these acids containing 55 to 60 per cent of meta cresol, which is known to be a more powerful disinfectant than phenol and the other cresols. Irritant properties have been removed from the tar acids during the course of manufacture, and the caustic action of the cresols is reduced by the fatty acids present in the preparation. The carbolic acid coefficient by the Rideal-Walker test is three. The odor is particularly pleasant for a preparation of this nature. It is made of a uniform quality, has no corrosive effect on instruments and does not blunt knives.

Colloidal Copper Hydroxide as a Fungicide.—Ordinary Bordeaux mixture, which is commonly used as a fertilizer, has several important disadvantages and defects. For example it does not stick and is liable to scorch. To remove these disadvantages it has been recommended that the colloidal copper compound be used instead of the ordinary substance. This colloidal compound was prepared by the addition of a 10 per cent solution of caustic soda to a solution of sulfate of copper, with constant stirring, any excess of soda being avoided. The precipitated hydrate was repeatedly washed with distilled water by sedimentation. When all the salts were removed, the copper hydrate on shaking with water, gave a colloidal solution which foamed, and contained copper hydrate to the extent of one part in one thousand. It remained in suspension for several weeks. Preliminary tests have indicated that such colloidal copper hydrate in a one to five thousand concentration has excellent sticking properties and is fungicidal to apple scale and blotch.

Linoleum Adhesive Preparations.—It is often desirable to fasten linoleum or oil cloth direct to the floor, which may be wood or cement. The cement that is recommended for this purpose is made in the following manner. Twenty-five parts of Venetian turpentine are used as a solvent in which 30 parts of rosin and 70 parts of Manila copal are dissolved. After a homogeneous mixture is obtained which is achieved by heating the substances, it is mixed further with 22 parts of linseed oil. This mixing is accomplished while the first mixture is still hot and on the fire. Then the composition is removed from the fire and 35 parts of denatured alcohol are added. The result is a linoleum adhesive of first-rate sticking properties.—*Chemische Umschau.*

A New Camphor Substitute.—The laboratories of the Bayer Co. in Germany have produced a new substitute for camphor which bears the name of hexeton. It is said that the effects and properties possessed by hexeton are identical to those of camphor from the qualitative standpoint but that hexeton is approximately twice to four times as powerful as camphor.

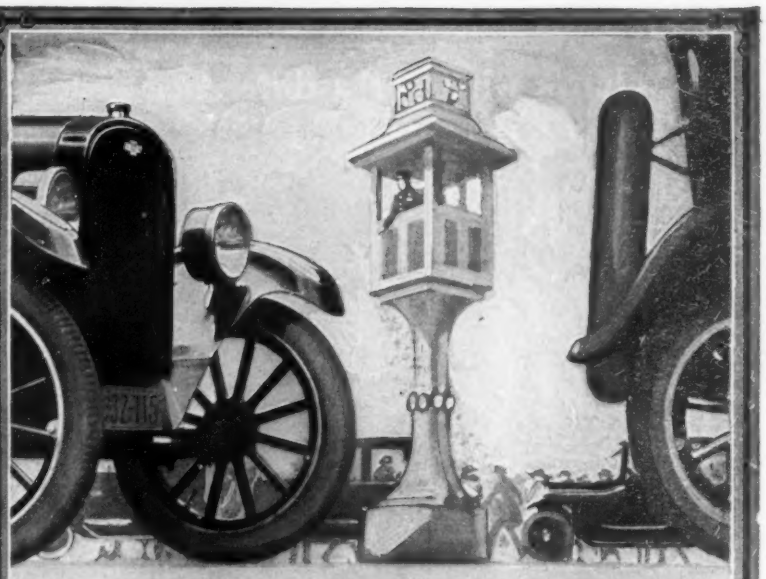
Oils from Olive Husks and Grape Stones.—The French journal *Les Matieres Grasses* contains a new method for the extraction of oils from olive husks and grape stones. The characteristic features of this method are as follows: In the place of using carbon disulfide, ethylene trichloride is employed because it is not nearly as inflammable as the first named solvent. Furthermore, the solvent power of this substance is almost as great as those of the solvents commonly used for oil extractions. It however possesses the additional advantages that its action is very rapid. The losses in the solvent are only 0.5 to 0.8 liter per hundred kilograms of material treated. The solvent works better at a slightly elevated temperature. The grape stones, and other material that is to be extracted, remain in the extraction apparatus for a period of approximately two hours, which is long enough to remove practically all the oily constituents that they contain. Then the mixture of oil and solvent is sent to the distilling apparatus where the ethylene trichloride is evaporated by the action of dry superheated steam. After the oil is freed from all traces of solvent, it is collected through a suitable draw-off cock and the solvent is recovered. The apparatus in the plant consists of a crusher, a dryer for receiving the cake from the crusher, and a boiler which is used for generating the high pressure steam required for the distillation process. Two extractors are necessary, each having a capacity of from 500 to 600 kilograms. A multiple condenser completes the installation. With this apparatus it is possible to extract from 3500 to 4000 kilograms of raw material daily. The condenser requires from 10 to 15 pounds of water per minute. The yield of oil is a little better than 10 per cent of the weight of the cake.

Electro-Magnetic Treatment of Steels.—An interesting paper was recently read before the Institution of Production Engineers in London on the subject of the electro-magnetic treatment of steels. In this talk it was brought out that in the heat treatment of steel it is not only important to know the temperature of the steel, but also the time it has been maintained at that temperature. Steel containing not more than 0.4 per cent of carbon could be hardened perfectly by quenching at a temperature of 750 degrees C., if it had been heated slowly; while to obtain similar results with rapid heating a temperature of 810 degrees C. would have to be reached. The point emphasized was that the steel should be heated until its magnetic properties disappeared. It was mentioned that the electro-magnetic method of treating steels was applicable, with slight modifications, to a wide range of alloy steels.

Products from Marine Animals.—At a meeting of the American Leather Chemists Association a rather interesting paper was delivered on the products that are obtained from marine animals. The paper dealt particularly with the products that are gained from sharks. It was said that in tropical water sharks that vary in size from two to twenty feet are caught, the average size being ten feet. The most common method used for catching is by the use of gill nets. These are 300 yards long and 12 feet deep and are suspended in the water by buoys and anchors. The small fish are allowed to pass through the net while the large fish are retained. On pulling in the net a blow is delivered by one of the men between the eyes of the shark. It is then hooked in the mouth and hauled on board. A good boatload is 40 sharks, although 100 can be handled. Skinning is done by cutting down the back and working the skin over the sides and belly, any adhering flesh being subsequently removed. The skin is now salted down, ready to be sent to the tannery. The liver can now be used for oil recovery, as it contains approximately 50 per cent of oil, which for some purposes might replace cod or menhaden oil. The bulk of the flesh is used either as manure or poultry food.

Pimento Seed Oil.—Pimento seed oil is a comparatively new product. The seeds contain approximately from 18 to 19 per cent of oil, which corresponds to forty gallons of oil per ton of seed. It is dark red in color and contains 2.3 per cent of free acids.

Coloring Mature Fruits.—The Bureau of Chemistry has developed a process for coloring mature citrus fruits. This process is now being quite generally employed in California. The use of ethylene displaces entirely the old process of bleaching by means of coal-oil burners with or without special humidifying means. In the new method the ethylene is merely forced into the sweat room, and if the room is tight only about one cubic foot of the gas will be needed twice daily for 5000 cubic feet of air space. If the "gassing" is done under canvas, the quantity of ethylene employed is doubled. The coloring, depending on the amount of green color in the fruit, is accomplished usually in two or three days, the maximum being five days and the minimum 1½ days. The proper temperature for oranges is from 70 to 75 degrees and for lemons from 60 to 65 degrees. The "gassing" has also been done by forcing the ethylene



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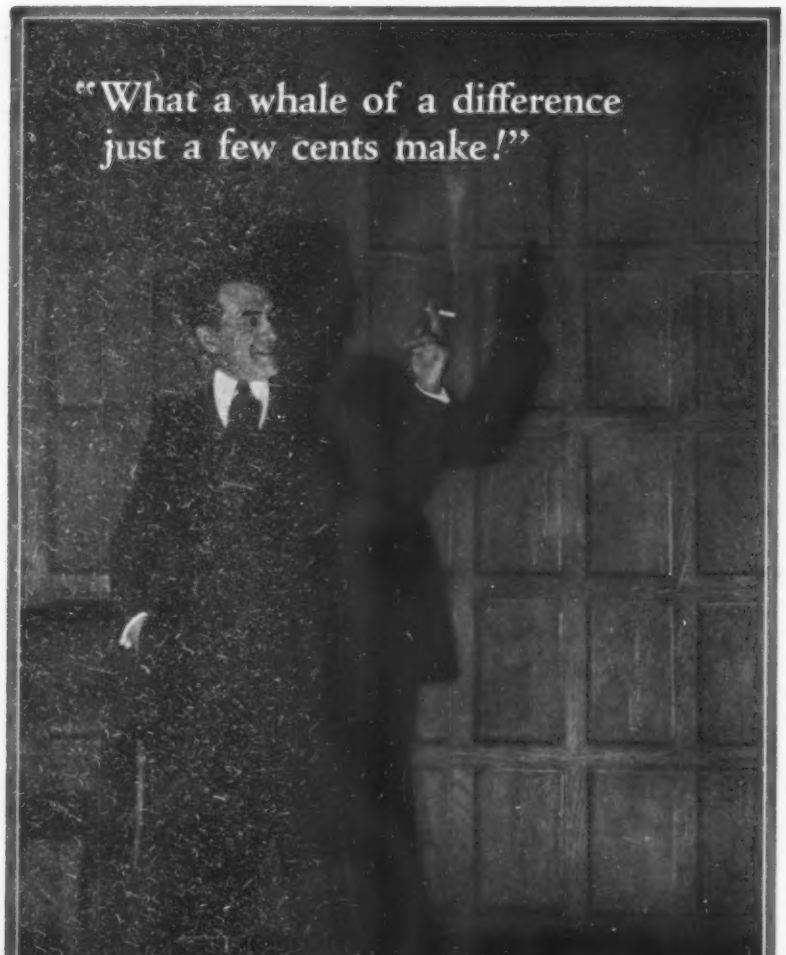

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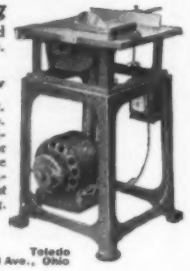

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into cars already loaded. Five cubic feet per car per day has been found to do the work. The cost of the bleaching by this process runs from 34 cents to 80 cents per car of fruit. This depends however, on the length of time consumed in the bleaching operation as well as on the number of gas applications per car.

Paint Plasticity Factors.—The practicability of expressing quantitatively the effects produced upon a paint by long grinding, by changing the concentration of the pigment, by adding soaps, water, mineral oil or deflocculating agents and the like is pointed out by E. C. Bingham and A. C. Jacques in *Industrial and Engineering Chemistry*. Since the yield value and mobility are independent properties, these factors affect now one of these properties, then the other, and sometimes both simultaneously. This independence and the occasionally prodigious magnitude of the effects enhance the importance of the plasticity method. Comparative results of experiments are given.

New Deposit of Soapstone in Austria.—It is reported that an enormous deposit of soapstone has been discovered in Zwettl, not far from the Bohemian frontier. The soapstone, which is stated to require very little preparation, can not only be cut, sawn, drilled and polished, but will absorb many colors, a property that should lead to its extensive use in powder form in the color industry. The deposit is the most important of its kind yet discovered in Central Europe.

Liquid Oxygen as an Explosive.—Liquid oxygen explosives have been successfully used in Colorado by the Department of the Interior in experimental mine blasting and road construction work at a cost of approximately half that of the gelatin dynamite required to do the same work. A liquid oxygen explosive consists of carbon black, wood pulp or some other carbonaceous material made into cartridges and soaked in liquid oxygen. This explosive can be detonated similarly to ordinary dynamite with cap and fuse or with electrical detonators. Besides costing less, the liquid oxygen explosive is said to be much safer to use than ordinary dynamite. There are disadvantages resulting from its use, however, and much is yet to be learned before it can be universally adopted in metal mining.

Sulfuric Acid Manufacture.—In *Chemiker Zeitung*, 1922, page 699 there is given a short description of a new method of making sulfuric acid in which the chambers are replaced by horizontal cylinders provided with a number of perforated plates. This method is being worked on a practical scale in South Africa. The hot sulfurous acid gases first pass through a Glover tower, where they are cooled down to about 80 degrees C. and at the same time they increase the acid content of the irrigating acid liquors from 66 per cent to 78 per cent. Then the gases, mixed with water vapor, are made to enter the horizontal cylinders at the bottom, meeting a downward current of nitrosyl sulfuric acid. Accordingly, the acid is freed from its nitrogen content while the sulfur dioxide is converted into sulfuric acid, with resulting increased concentration of the outflowing acid. The evolved nitrogen oxide gases are again absorbed in two Gay-Lussac towers, connected in series and used further in the process.

New German Motor Fuel.—A new German motor fuel, under the name of benzolite, has appeared on the market both in Germany and in England. This fuel is a patented product and consists of 50 per cent benzol, 20 per cent gas oil and 30 per cent of alcohol. It is said to be the successor to a preparation known as "tetralit" which was a mixture of benzol and tetralin. The new fuel is a water-white liquid derived from naphthalene and is of about 0.975 specific gravity at 30 degrees C., flashing at 78 degrees C. and of high B. T. U. capacity. In practice it is mixed with an equal quantity of petrol or benzol.— *Oil Paint and Drug Reporter*, November 12, 1923.

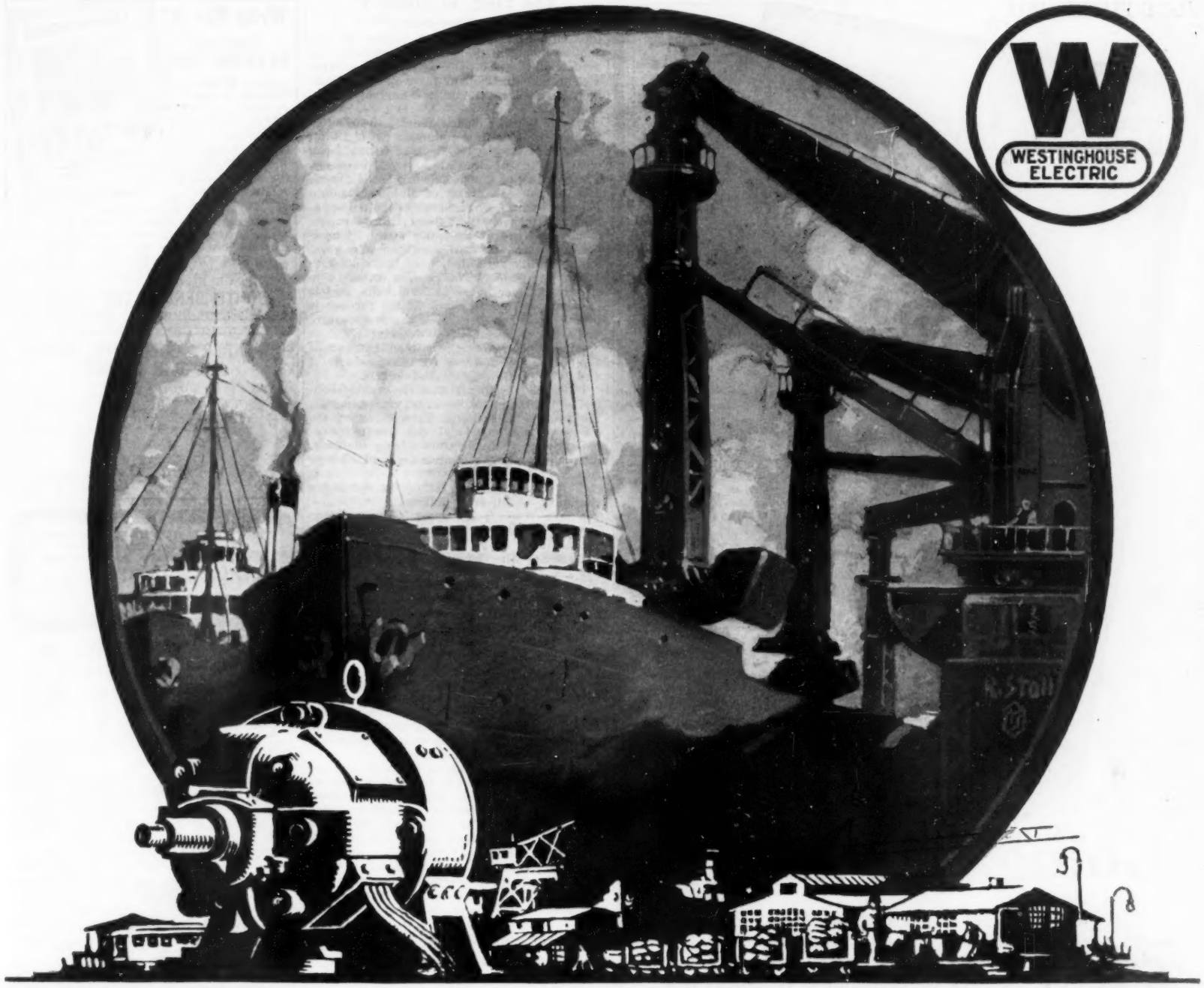
Use of Water Glass in Paving Streets.—In the city of Locle, Switzerland, according to the *Chemiker Zeitung*, a macadamized road was built in which the sand that was used in making the top surface of the road was first treated with a solution of water glass. About one hundred and twenty liters of ordinary water glass were used per cubic meter of sand. It is claimed that the road, made from material treated in this manner, lasted three years. After the application of the top surface the road was well rolled to make it as smooth as possible. Very heavy traffic passed over the road in the three years that it was in use. It was found that the water glass had penetrated to a depth of ten centimeters and had cemented together the particles of sand and dirt into a firm, solid mass for the same depth.

Glycerin as a Seal for Liquefied Hydrogen.—One of the difficulties which the United States Bureau of Standards has encountered in the liquefaction of hydrogen is the securing of hydrogen of sufficient purity. If other gases are present, they become frozen at a temperature higher than that at which hydrogen liquefies. This clogs up the apparatus and stops the process. The storing of hydrogen in any kind of a gas holder is therefore a matter of some difficulty because gases are very apt to diffuse through the liquid seal used in the holder and become mixed with the hydrogen. Experiments were made during recent months on the relative rates of diffusion of nitrogen through glycerin, machine oil and water. It was found that the rate of diffusion through glycerin, is much lower than through water or machine oil. This was to be expected because of the extremely low solubilities of nitrogen and other gases in glycerin. The Bureau now proposes to employ glycerin as a seal for the gas holder used for the temporary storage of pure hydrogen.

Plombit, an Acid Resistant Material.—This is the name given to a product that has recently appeared on the German market. The material is in the nature of an artificial asphalt which can be obtained in any desirable color and of higher melting point than is possessed by the ordinary run of asphaltic substances. The melting point of the plombit substance is in the neighborhood of 130 degrees C. It is made in a variety of colors and is completely odorless. According to the patent specifications it is a complicated combination of oleic acid with hard rubber plus the addition of concentrated sulfuric acid and free sulfur. The new product is of considerable interest to chemists for the substance is perfectly acid-proof, as it resists all sorts of acids in varying concentrations and is therefore well suited for lining the walls and bottoms of acid tanks and containers of all sorts, and also for the protection of machinery that is subjected to acid vapors and fumes. The process of covering the metal apparatus with the plombit plates is somewhat as follows. These sheets which look much like cement or ceramic plates, are dipped into the molten plombit and cemented together, so that an even surface, free from cracks or openings of any sort is obtained. For further details see *Chemiker Zeitung*.

Synthetic Marble.—A new process of manufacturing synthetic marble has been devised in which the marble is made by a wet method in place of the fire method. A mixture is made of chloride of calcium and an aqueous solution of sodium carbonate or a mixture of precipitated carbonate of lime and sodium chloride solution is heated in autoclaves at a temperature of 300 degrees C. and 24 atmospheres pressure for a period of eight hours. A compact mass is obtained in this manner. The product resembles marble, has the same high lustre. When sodium sulphate is employed in admixture with chloride of calcium a product is obtained which resembles alabaster.—*Chemiker Zeitung*, 1923.

Hexalin Soaps.—Hexalin and methylhexalin soaps are being made and used in Germany on a large scale for various textile and laundry purposes. The composition of some of these soaps is given below. This data was derived from the German periodical, called *Seifensieder Zeitung*. In the first formula the soap is made from a mixture of 500 parts of linseed oil, 250 to 300 parts of hexalin, 199 parts of potash lye of 50 degrees Be., and 1208 parts of water. Another formula consisted of 500 parts of rape oil fatty acid, 500 parts of hexalin, 195 parts of potash lye, 50 degrees Be., and 1705 parts of water. Still another formula consists of 200 parts of cocoanut fat, 130 parts of linseed oil, 200 parts of hexalin, 156 parts of potash lye and 880 parts of water. Products which resemble soft soap are made from the following formulae: 500 parts of linseed oil, 300 parts of methylhexalin, 100 parts of caustic potash lye, 50 degrees Be., 140 parts of soda lye, 36 degrees Be., and 230 parts of water; 500 parts of linseed oil fatty acid, 300 parts of hexalin, 52 parts of potash lye, 250 parts of soda lye and 300 parts of water. These ingredients are mixed together in a kettle heated with indirect steam until a clear solution is obtained. The hydrogenated phenols, hexalin and methylhexalin, aid in the saponification of the fats by the alkali so that the manufacturing process is shortened.



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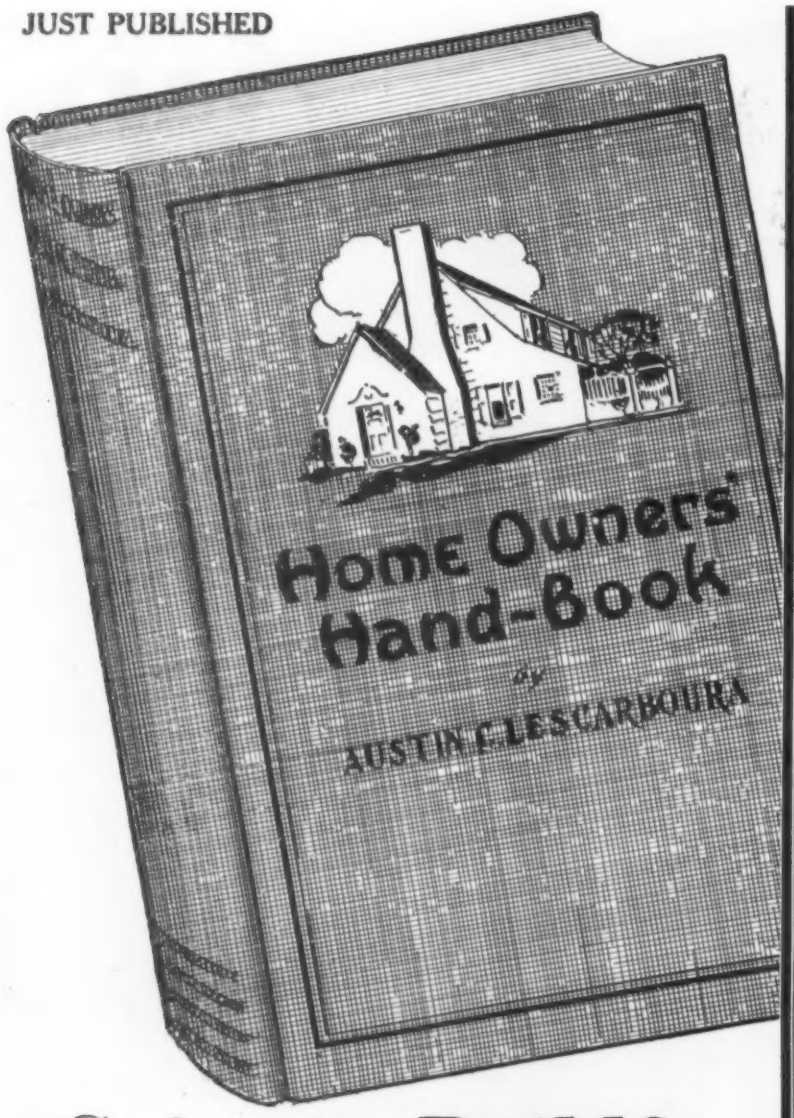

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The Story of Steel—V

(*Continued from page 310*)

the adjoining transformer house to the holders that grip the carbon electrodes. The bottom of the electrodes is maintained with a clear spacing of about three-quarters of an inch between them and the surface of the slag.

At the South Chicago Works, the electric furnace is used in conjunction with 25-ton Bessemer converters and large tilting basic open hearth furnaces of 200 tons capacity. The capacity of the electric furnace is 25 tons and the charge consists of all-blown molten Bessemer metal, or a charge of molten open-hearth metal from the 200-ton tilting furnaces is used instead of Bessemer metal. Three-phase current is used, and the amperage, automatically regulated, runs from 6000 to 14,000 per phase. The current comes in to the transformer house at 2200 volts, and is transformed to 110 volts. If the furnace is producing .80 carbon steel, the temperature will rise to about 2750 degrees; if it is making .08 carbon steel, the temperature will rise to 2850; and for certain products it will reach 3000 degrees Fahrenheit.

It is needless to say that the perfect control of the temperature at all times, during the process of refining, as well as of the chemical reactions, and the possibility of making many sample tests during the heat, are among the great advantages of electric refining.

The sequence of operations in refining a charge of metal, is as follows.

First: Twenty-five tons of blown molten Bessemer metal or open hearth metal is poured in.

Second: The electrical current is turned on.

Third: 1400 pounds of lime, and if Bessemer metal be used, 900 pounds of iron oxide are added. This forms a slag for the removal of the phosphorus.

Fourth: After the phosphorus has been reduced from .09 to .008 of 1 per cent, the preliminary or oxidizing slag is removed from the furnace, and a new (reducing) slag is made by shovelling in 1100 pounds of burnt lime, 200 pounds of sand, 200 pounds of fluorspar and 200 pounds of coke dust—all for the purpose of deoxidizing the metal, and eliminating sulfur.

Finally, when the metal in the charge has been thoroughly refined, the proper amount of manganese, nickel, vanadium, chromium, or other alloy is added to produce the alloy steel required. The treatment, as above described, lasts about four and one-half hours.

In the next chapter of the series we shall deal with the open-hearth system, by which the bulk of the huge output of steel from our American mills is produced.

Exploring Within the Steel

(*Continued from page 317*)

graphic record is being made, the record is a straight line.

When, however, a discontinuity such as an inclusion, a crack, or a hard or soft spot passes through the solenoid a red light flashes or a bell is rung and the spot of light on the galvanometer scale moves sharply, while the photographic record is no longer a straight line but shows a hump.

As applied to an elevator cable: supposing that a single wire has been broken, even if the break is inside the cable and is invisible to the eye, the defectoscope not only shows that there is a break but it shows exactly where it lies. This fact is especially valuable in application to elevator or mine hoist cables that have been in continued use. The solenoid can easily be installed around the cable, the control and recording device being located at any desirable place, whether quite remote or not.

A highly interesting installation of the defectoscope is now in regular use in Schenectady where it is used for testing the bucket wheels of large steam turbines. Some of these forgings are as large as ten feet in diameter and four inches in thickness. They must be of unquestioned integrity, for the stresses put upon them by revolving at a high rate of speed are extremely high. By beginning the defectoscopic analysis at the periphery of the disk and moving toward the center in a spiral the analysis is made in much the same manner as if the disk were a single long piece.

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proved bad in service. Because of microscopic blowholes and other defects which would have remained unknown had it not been for the use of magnetic analysis from ten to twenty per cent of these expensive disks have regularly been thrown out.

In one case this particular instrument indicated a bad spot that seemed to be about the general size and shape of a cigar box. However, since the steel from which the forging had been made had a very satisfactory chemical analysis, but for magnetic analysis the disk would have been accepted. In fact, so sure were the proponents of the magnetic method that there was a large inclusion of some sort in the large forging that they agreed to repay the cost of the forging if their belief proved inaccurate. Therefore, the disk was cut open. The suspected area was found to contain the fragmented pieces of a broken brick! This brick, as illustrating the total depravity of inanimate things, had managed to get into the blooms during the rerolling of the ingot and had been crushed. The pieces were distributed over a considerable area, providing the potential cause for a centrifugal explosion had the disk been used in a turbine.

The testing of large circular specimens like car wheels, locomotive tires, fly wheels, large gears and elevator sheaves in a similar manner to that of the turbine disks has also been commercialized.

Steel rails were formerly made by the Bessemer process, but it was impossible entirely to eliminate the danger of an occasional batch running a little too high in phosphorus. This element has the effect of causing "cold shortness," or brittleness, especially in cold weather, and many disastrous railway wrecks have resulted from this fact. But rails are now made by the open hearth process and are practically free from this danger. They cost more to make, but the railroad companies do not hesitate to pay a higher price for them, in fact for two decades they have voluntarily paid a bonus for rails of high standard.

In one case a serious wreck was caused by the accidental inclusion of a common bolt which had got into the molten metal in the rail mill and due to some cause which a chemical analysis would have probably shown, had failed to dissolve in it. This included bolt had weakened the rail until it broke at the critical moment. A simple installation of the defectoscope would have prevented that particular rail from ever leaving the mill.

In the Burrows laboratory in Jersey City the writer witnessed one particularly simple but significant demonstration of the defectoscope's ability to "spot" defects in steel rails. A rail that had been in use on a railway during a period of some years was placed in a horizontal position, and a defectoscope was mounted on a movable carriage in such a manner that it was able to traverse the entire length of the rail. First it was explained that a well-camouflaged artificial "flaw" consisting simply of a small hole had previously been drilled into the webb of the rail at some point along its length. This had been filled with putty and the job concealed with pigments. As the solenoid moved slowly along the length of the rail it was observed that the beam of the galvanometer swung slightly at definite equal intervals of about eighteen inches. Then, at one point it swung quite sharply left. The latter phenomenon had accurately located the hole, while the former stood as an indication of the strains that had been put upon the steel at the cross ties.

As the defectoscope must not be too sensitive for commercial use, and must be able to distinguish between insignificant and serious flaws, it can be adjusted to any desired tolerance in this respect.

The magnetoscope unlike the defectoscope does not always give an indication of the existence of flaws. It is used for checking the general physical properties such as hardness, grain size, chemical composition of a piece of steel or iron against the like properties of a standard piece. For example, using one of the types of magnetoscope, the magnetic comparator, suppose a certain piece of material is known to possess the exact properties wanted for making a tool and it is desired to know whether these properties have been duplicated in other pieces of material. In this case two identical solenoids each having its own system of exploring coils, are provided. In one is placed the standard material; in the other, the material to be checked. The two solenoids, energized by alternating current, are connected in series and the test coils are connected in opposition. If the two specimens are not identical in their magnetic properties a differential effect will be measured on an indicating device. This is because the voltages set up in the respective test coils are different.

The standard piece may be of any convenient length, while the piece to be tested may be in a continuous length and may be drawn through its coils at any desired speed up to 200 feet per minute. The deflections on the indicating device may be read by means of a lamp and scale, or they may be made to close the contacts of a delicate relay so that signal lights and bells, or a marking device may be energized.

Examination of small circular pieces such as balls, ball races, rollers, and piston rings by means of the magnetoscope makes the location of cracks, flaws and segregations easy. In addition, variations of quenching temperatures of as low as 10 degrees are detectable. This method has just been adopted for testing the bevel gear rings of a well-known make of motor car.

Drills, for instance, which have received proper heat treatment are readily separated from imperfect drills, and laminated regions in plates can also be determined by means of one form of the magnetoscope.

The application of magnetic analysis to irregular shapes must be considered individually, for while the detection of flaws is usually possible, it is not always necessary when the raw stock has been certified magnetically. The item of greatest interest in semi-finished parts is the correctness of the heat treatment, and it is in the sorting out of properly heat treated articles that the application of magnetic analysis to irregular parts and small shapes finds its widest usefulness.

Magnetic analysis is also applicable to the study of growing fatigue strains in steel under stress while in service. These strains bring about a change in the magnetic qualities of the steel. For example, during the life test of a new model automobile, airplane or other machine the model may be disassembled and the parts examined magnetically, permitting the detection of defective parts before the defect has otherwise made itself discoverable.

In short, practically three-quarters of the steel products of the world are potential subjects of magnetic analysis, and when they have become actual subjects the factor of safety allowed in most steel construction work will according to the proponents of the method, be materially decreased, while the losses due to mysterious failures will greatly diminish.

Post-Treaty Standing of the World's Navies

(*Continued from page 320*)

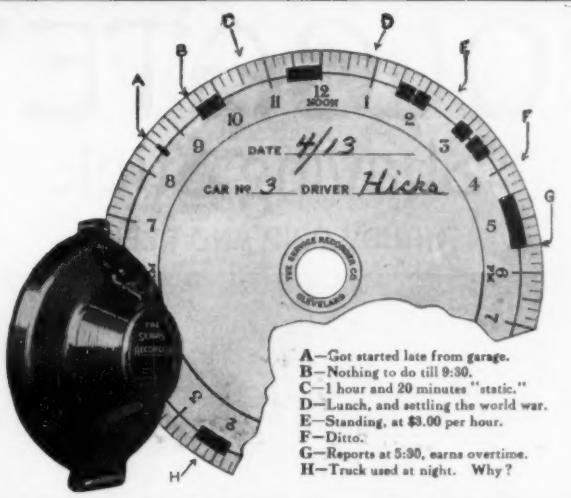
ment we also show a large predominance, with 93 ships. In fleet submarines of 1000 tons and over, however, we make but a poor showing, Japan has 24 ships in this class against our six, the eight possessed by Great Britain, and nine by France. Our position is strong in aircraft carriers; and this is due to our conversion of two of our huge battlecruisers, 876 feet in length and with a designed speed of 33 knots, into aircraft carriers. Japan should have come next with three ships in which two battlecruisers were to have been included. One of these, however, was injured in the earthquake and a battleship has been converted in its place.

We have drawn up this comparison with a view to placing before Congress and the country the urgent need for the construction of at least eight or ten light cruisers of the 8000 to 10,000-tons class. The conference permits the arming of such vessels with guns up to eight-inch caliber, and a squadron of 10,000 ton, 32-knot vessels, carrying eight of these weapons, and with a steaming radius that would enable them to cruise anywhere on the main sea routes of the world, together with the construction of a dozen flotilla leaders, would go far to correct the present want of balance in our fleet.

Making High-Tension Cables

(*Continued from page 325*)

front through a die somewhat larger than its own diameter, the difference being usually about 1/4 or 9/32 inches. As the cable passes through this chamber a pressure of 500 pounds per square inch is exerted on the plastic lead by the hydraulically operated piston. This pressure forces out an envelope of lead around the paper cable as it passes through the die. The reason for having the lead plastic instead of molten is twofold. First, because it must not be hot enough to damage the paper or compound and second, because if fluid it would squirt



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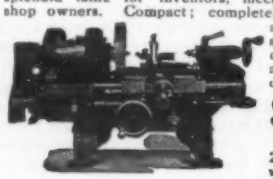

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out all over the place and would not form evenly around the cable, or hold its shape.

Cables, any more than any other kind of electrical apparatus, cannot be delivered without first being tested to make sure that they will give the service for which they were designed. In service they must often undergo a considerable amount of bending during the process of installation, they must be able to withstand voltages a good deal in excess of the operating voltage, on account of momentary surges, and all the other electrical characteristics already touched upon must be checked up. That means that bending tests, as well as voltage, conductor resistance, insulation resistance, and dielectric loss tests must be made.

There are some points about the voltage test which illustrate particularly well how carefully the design of high tension cables has been studied, and necessarily so. The duration of excessively high voltage is of importance as it has been found that an insulating material may withstand a very high voltage momentarily but will fail if it is sustained for several minutes. It is also a fact that the kind of voltage has a direct bearing on the strength of the insulating material. That is, insulation such as impregnated paper can withstand something like two and a half times the voltage with high tension direct current that it can with 60-cycle alternating current, but with high frequency or oscillating voltage, such as from condenser discharges, it fails at about half that voltage. Thus in testing care must be taken not to damage the cable by using the wrong kind of voltage, or in operating under service conditions to permit the production of surges, very likely of high frequency, by improper switching methods or otherwise.

So it will be seen that it is not a simple matter to convert old ropes and oil refinery refuse into a scientifically designed and perfectly manufactured product, for with high tension cables, where the forces to be controlled are so powerful that they will most certainly search out the slightest weakness, nothing short of perfection will suffice.

Truffles and Truffle Hunters

(*Continued from page 332*)

from the common truffles of Europe that they are placed by botanists in a distinct family.

The first truffles known to the French were the white summer species, *Tuber aestivum*, and the Bourgogne truffle, *Tuber uncinatum*. The former soon came to be known as the "English truffle," since it was one of the commonest species in the London markets, being found from midsummer to autumn in beech, oak, and birch woods. It is about as large as a small apple and is covered with conspicuous black warts, while the flesh is brownish with white veins. The odor is very strong and penetrating and the flavor agreeable.

That queen of all the truffles, the Périgord, or *Tuber melanosporum*, was not discovered until about the end of the fifteenth century. At the present time, when the "French truffle" is spoken of, this is the kind that is meant. Périgord pie, more commonly known as *Pâté de foies gras*, is flavored with this species, which is famous for its delicate aroma, its uniformly good quality, and its regular shape. It is about the size of a walnut, rounded in shape, brown or black externally and ornamented with coarse warts, while the interior is blackish-gray variegated with white veins. The odor is very pleasant, resembling that of a strawberry when the tubers are young and becoming powerful with age. It occurs during the autumn and winter months under oaks and beeches, the live-oak being its favorite shelter-tree.

The "Italian truffle," *T. magnatum*, has a strong odor resembling that of garlic or decaying cheese. It is quite irregular or lobed in shape, without warts, yellowish or brownish-yellow externally and pale-liver-colored veined with white within. Although usually the size of a walnut, it sometimes weighs as much as ten or twelve pounds. It occurs in late autumn in clayey soil under willows, poplars, or oaks, and rarely in cultivated fields. Unfortunately, its flavor does not equal its odor in strength.

Another onion-scented species, *T. macrosporum*, is sometimes found in England beneath oak, beech, and willow trees.

One of the characteristic winter species is *Tuber brumale*, which is round and black, with sharp warts and the usual variegated flesh. Its odor is very strong and lasting.

The "white truffle," *T. album*, occurs in England, Germany, and southern Sweden, growing half above the ground and half buried. It is about the size of a large walnut and has a whitish-red tint.

In the market at Trent, Italy, where I have made careful observations of the edible fungi, the following species are usually found: *Tuber aestivum*, *Tuber brumale*, *Tuber mesentericum*, *Tuber melanosporum*, and *Tuber uncinatum*. In France, several million dollars' worth of truffles are marketed annually at from one to two dollars a pound, many of which find their way to America. In 1913, nearly half a million pounds were exported from France to other countries.

One October day not many years ago, some truffles were sent to our herbarium that were collected under oaks in the suburbs of New York City, with the aid of a dog trained in Italy. Two gentlemen had conceived the idea of developing our native truffles and raising dogs to supply the needs of those who wished to hunt them. The idea was a good one—scientifically if not commercially—and we encouraged it. The dog was taken to an adjoining state and found other specimens, which were also sent to us.

Three species of truffles had previously been reported from the eastern United States, but the records were scanty and the specimens few. Here were the actual fresh specimens; not many, to be sure, but still in sufficient quantity for scientific investigation. Anyone now finding this species can readily recognize it from the description or by comparison with the preserved types. This new species, as published by Miss Gilkey, is yellowish-brown, sometimes furrowed, without warts, one-half inch in diameter, yellowish within, marked with white veins. The sacs contain from one to four spores, which are large, yellow, and beautifully sculptured. It occurs in New York, New Jersey, and probably in other eastern states.

The possibility of finding native truffles of commercial importance in this country is rather remote, since they would almost certainly have been discovered already by the French people of the South or the Italians of the North. However, there are sections in Virginia and the Carolinas settled by people who probably never saw truffles and it might be well to institute a careful research in those States and in regions lying to the west of them. If truffles exist there in abundance, the hogs certainly know it by this time, since it is customary to turn these animals loose in the forests and let them make their own living by hunting acorns and chestnuts and digging up poke-root.

The introduction and cultivation of commercial species would seem perfectly feasible on theoretical grounds, since all the necessary facts and conditions now appear to be known; but careful experimentation alone would determine the accuracy of this conclusion. The following conditions would be essential.

The *soil* must be light, shaded, properly drained, rich in decaying matter, and containing a certain proportion of lime and clay. Sandy soils are too dry and too poor to grow truffles, even if lime were added to them.

The *climate* conditions of France and Italy furnish a criterion. New York is too cold for the best winter species, although some truffles found in northern Europe might grow here. Southern California is probably too dry, but farther north on the Pacific coast there is plenty of rain, as well as moderate temperatures. The limestone regions of Virginia and southward would seem to be ideal localities.

The best *shelter-trees* of Europe are probably the truffle oak, the evergreen oak, and the hazel. These and other European species might be planted in this country in places where they would do well; or a number of our native trees and shrubs, such as oaks, beeches, hazelnuts, birches, elms, poplars and willows, might be used experimentally.

The *spawning method* most largely used in France for establishing new truffle grounds is to take soil from truffle beds and spread it over the new ground. Another method, called colonizing, is to plant mature truffles just as one would plant potatoes, but without the same assurance of success. If there is any virtue in the new method of making artificial cultures on leaves, it would soon appear in a new country where true truffles did not exist. In the case of the ordinary mushroom, excellent spawn may be grown from the flesh of the cap, without using the spores at all. These and other methods might be tried in several well-selected localities in the United States, which, in the event of success, would serve as centers of distribution of the spawn.